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Notes of
Lectures
upon
Chemistry
By

William Cullen M.D.

taken by
Benjamin Throck

M: Rouelle of Paris defines Chem^y:
thus.

" La Chymie est un art physique qui
" par le moyen de certaines Operations et
" de certains Instruments, nous enseigne
" a separer les Corps plusieurs Substances
" qui entrent dans leur Composition; et a
" les recombinaer de nouveau entr'elles
" ou avec d'autres pour reproduire les
" premiers Corps ou pour en former de
" nouveaux. L'utilité des Arts, & les besoins
" de la vie sont le but qu'elle se propose.

Chemistry instead of being ^{the} most
ancient, is really ^{the} most modern of
all Sciences. even to this day w: most
of People the Idea of Chemistry is limited,
imperfect and inaccurate. They do not
agree concerning ^{the} nature of the
Art. Therefore since our notions of
Chemistry are not ^{the} most common,
we think it necessary to begin by giving
the Ideas w: Chemists themselves have
had of their Profession.

Towards ^{the} End of ^{the} 16th Century, soon
after Paracelsus, Pennertus gives

The following Definition of it in his
"Disputatio de Consensu & Dissensu
inter Galenicos et Chemicos". It is (says
H) the art of resolving minerals for y^e
purposes of Pharmacy & Alchemy. This
Notion of Chemistry is so visibly insuffi-
-cient that we shall not insist upon y^e
Faults of it, but proceed to Bequius
who says -- it is y^e art of resolving and
compounding Minerals for y^e purposes
of Pharmacy & Alchemy. -- He insinuates
you see a little upon his Pudefession by
adding y^e word compounding, but y^e
Insufficiency of this Opinion is so
apparent, y^e we shall pass on to

Romberg's who says "Chemistry is $\frac{2}{4}$:

Art of resolving and compounding mi-

nerals by means of Fire. This is an

Improv^r upon $\frac{1}{4}$ & two former, but he

has put a heavy blog upon it when he

says "by means of Fire." —

Macquair's Definition Abounds wth:

Terms as difficult to be understood as $\frac{2}{4}$:

word Chemistry itself. in short all who

have attempted to define Chemistry have

erred by considering it as an Art, and not

as a Science.

Dr. Shaw has endeavoured to give us

a full Definition when he says "Philoso-

phical Chemistry is $\frac{2}{4}$: Art of dividing

4^m

all Bodies within our power, by all γ :
Instruments within our power, but
from these words it is impossible to
determine what is a Chemical Ope-
-ration. for instance γ : Method of making
shot by dividing γ Lead after Fusion into
small parts is really a chemical Operation
- when Sugar is reduced to powder in
a Mortar it is also divided into smaller
parts, yet it would be as absurd to call
 γ : a Chemical Operation as γ : Having
a Beard, or chipping a Block.

The great Boerhaave attempted a
Definition of Chemistry, but in Reality
he says little to γ : purpose. from his
Failure in γ : Attempt we may con-

That [&] Task is extremely difficult.

To give them a more accurate and simple Idea of Chemistry, we must look upon it in a different Light from that in which it has been hitherto examined, by considering it as a Branch of Natural Philosophy. Nat: Philosophy is its Genus, but what is its Species? Boerhaave in his Methodo Studii Medici, says that Science which explains [&] particular nature of Bodies, and whereon [&] Formation of those Bodies depends is a Branch of Nat: Philosophy, & is called Chemistry. — This is partly [&] Definition we are enclined to adopt. viz: Chemistry is [&] part of natural Philosophy which treats

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of the particular properties of Bodies,
— to understand w. is meant by
general and particular properties of
Bodies I shall illustrate it by a few ex-
-amples. it must be observed that as
I Doctrine of particular properties of
Bodies belongs to Chemical, so the
Doctrine of general properties of Bodies
belongs to mechanical Philosophy. For
Example, Gravity is a general Property
of all matter, and therefore comes under
I Consideration of mechan. Philosophy. but
I Ductility of Gold & I Hardness of the
Diamond are particular properties of
particular Bodies, & therefore all under

2^d Class of Chemical Philosophy. An illus-
 tration of the Above Definition further, let us
 consider a knife. the Cutting of it depend
 upon its Form ^{or} is a wedge. this Form may
 be given to any Other Body. it is therefore
 a general property, and to be considered as
 belonging to Mechanical Philosophy. for
 Gold wrought into y: same Form would
 cut equally as well, if y: hand ^{or} w: use it
 was to press always ⁱⁿ y: same plain w:
 its edge. but seeing that is a moral Im-
 possibility, we must make choice of a
 Substance y: will bear to be turned a little
 from its perpendicular height or position
 & will return again to y: same. this pro-
 perty is called Elasticity, & is found very

& greatly in favor. the Choice then of Iron for
a Knife as possessing a particular property
is an Object of Philosophical Chemistry

No Other Definition y: I know of except
this w: we have adopted can give y: young

Student an Idea or first Rule by which
to distinguish what properly belongs to

Chemistry. I also flatter myself y: my

Definition may be applied both in Phys
and Other Arts. But y: you may more

fully comprehend my meaning, I shall
be able to distinguish better y: general from

y: particular properties of Bodies. I shall

delay you w: a few more examples.

In Physic y: Doctrine of Stimuli is ex
tensive. The Idea is taken from a Sp

extensive. The Idea is taken from a Sp

In considering ^{the} Animal Economy we
 see a great variety of Stimuli, i.e. Bodies ^{which} w:
 act upon it by Irritation & Spurring. ^{the} y:
 most evident kind of Stimuli are those w:
 are sharp-pointed. but there are others
 whose particles we cannot examine, &
 are therefore ignorant how they act as Sti-
 mulants. of late then we have divided
 Stimuli into Mechanical & Chemical.
 - the first are those which act like Spurr-
 ing w: their sharp-points - the second are only
 known by ^{the} y: properties of ^{the} Bodies in
 which they are found. all ^{the} y: we know of
 them is, that they are certain sharp irita-
 ting Qualities inherent in certain Substan-
 ces. - all ^{the} y: Difficulty then remaining is

To distinguish ^{ch} w: are general & w: are
 particular properties. for $\frac{1}{2}$ bitter tender.
 = Standing of this take an Example.

Here is a mixture of Chalk and Sand

put into a Vessel. it is required to separate

the mixture. Pour water for this purpose

upon $\frac{1}{2}$ Mixture, & stir it briskly.

When I cease from stirring $\frac{1}{2}$ large pan

of sand quickly subsides, & $\frac{1}{2}$ Chalk

remains suspended in $\frac{1}{2}$ water. if the

water is then decanted it carries off the

greatest part of $\frac{1}{2}$ Chalk leaving the

sand at $\frac{1}{2}$ Bottom of $\frac{1}{2}$ Vessel. $\frac{1}{2}$ Process

being repeated as often as is necessary

leaves $\frac{1}{2}$ sand perfectly separated from $\frac{1}{2}$

Chalk. if instead of water I add vinegar
 or any other Acid, y^e Chalk effervesces
 wth the Acid, and forms a uniform Body,
 nor will y^e Chalk be separated from y^e Acid
 by any length of time, y^e sand at y^e same
 time remaining unchanged. now let
 us enquire into y^e Rationales of these
 different Methods of performing y^e Operation,
 & endeavour by y^e Assistance of y^e Theory
 we have adopted which of these Operations
 can properly be called Chemical. y^e success
 of y^e first method depends upon Fluidity &
 Property not only of water, but of th^o of
 Wine-Rum-Brandy &c & any of w^{ch}
 w^e have performed y^e process equally as

well as water. it depends likewise upon
 y: respective size and weight of y: Sand
 & Chalk. This Operation is then certainly
 Mechanical. in y: Second Operation Cu-
 rity was y: Instrument. Acidity is a
 particular property, therefore y: Operation
 is Chemical.

Some argue a g: our pretending to
 establish general and particular properties
 from our not being sufficiently acqu-
 -ted w: Nature to know how far parti-
 -cular properties extend: & some late
 Discoveries which prove y: Quicksilver
 may be rendered solid, & y: hardest Diam-
 liquefied seem to strengthen this Opinion
 but as long as certain properties app-

in certain Bodies very constantly, such
 may be reckoned proper Objects of Chemistry.

From these Examples we may ven-
 ture to conclude that Chemistry is that
 part of natural Philosophy ^{which} ~~is~~ ^{treats} ~~of~~
 the particular properties of Bodies, and
 teaches us by various means to induce them
 where they are not, and destroy them where
 they are. —

Having now distinguished what does,
 and what does not belong to Chemistry,
 we shall next proceed to ^{the} Doctrine of this
 Science; but previous to this it may be
 necessary to say something of the method
 of conducting ^{the} Study of Chemistry w:

I shall give you ^a general plan w: I
 intend to pursue; from w: you will gain
 these two advantages 1: you will be directed
 by it to particular parts & 2: you will
 be enabled to keep in view ^a connection
 of the whole. —

The ultimate End of Chemistry is to learn
 & Causes of particular properties of Bodies, &
 & only means of arriving at that End by
 Induction.

Every Science may be reduced to two
 Heads. History, & Philosophy. under ^a 4:
 historical part I shall deliver first an
 History of ^a Objects of Chemistry. Secondly
 a general Acc: of the Operations & Instruments

of Chemistry, & finally the Chemical History
 2. Knowledge of those Facts which must
 lead us to 4. Knowledge of Causes, or
 the philosophical part of Science. Facts
 must be collected under 4. Titles of 4. parts
 - cular Bodies to which they belong; & the
 means pointed out by which their practical
 - lar properties are discovered, together with
 4. Manner in w^h they are induced or destroyed
 This part of the Study is extremely useful
 independant of 4. Causes of Qualities.
 No Person will doubt 4. Utility of knowing
 that Antimony has an emetic Quality
 4. means whereby this Quality may be
 increased or diminished, yet we do not know

The Causes of 4th Quality. Again it is ex-
 tremely useful to know 4th Aqua fortis
 dissolves Silver, but that it has no action
 upon Gold, yet we ^{do} not know why it dis-
 solves the One, and has no Effect upon the
 Other. —

In delivering the Chemical History
 of Bodies, you will frequently be refer-
 red to 4th Relation of Bodies to each Other,
 & to the Means by which this is discovered.
 I might illustrate this by an Example,
 but as I shall be obliged to employ Terms
 which I have not yet explained, it will be
 better understood hereafter.

You might here naturally enquire

²
 w: Books are to be read? - I am sorry
 to say y: upon y: Subject of Chemical
 History, no Books are written w: I can
 recommend to You, because they are
 incorrect deficient & without Order. ^{or}
 - there is there any Book yet published in which
 y: Language, or general Matter of Chemistry
 is presented accurately. Even ⁱⁿ Macquer's
 - misty, a Book w: I could most safely
 recommend to your Perusal I shall much
 sooner have occasion to refer you to the
 errors than to the excellencies of y: Author
 - its chief use is to show y: common Methods
 of conducting Chemical Processes.
 The first part of our Plan will

contain two principal parts. 1.st an
 Explanation of ^{the} Language of Chemistry
 2.nd an Acc.^t of the Objects of Chemistry.

This part you must consider not only
 as applicable to Chemistry, but likewise
 as a Compendium of Natural History.

The Second part of our plan will also
 contain two principal Heads

1.st the Rules of practice

2.nd An Introduction to ^{the} Theory of Che-
 mistry. —

The Order of the

Third part requires a particular
 Explanation. I shall therefore defer
 speaking of it at present. —

We shall endeavour in explaining the
 Terms of Chemistry to affix proper & distinct

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Idea *thout*. a needfull Lesson this! which
cannot be learned from any Glossary or
Dictionary. if upon any Question *one*
single Term occurs w: does not give you
clear Idea, rest not, till by considering
your Notes - reflecting on w: you hear,
enquiring among your fellow Students,
become perfectly acquainted w: its meaning.

It will be probably expected y: I should
deliver something concerning y: Doctrine
Qualities: But I must own myself
-tical in this Affair. Besides in y: present
State of Chemical Knowledge it will
impossible to render it complete. I resolve
however in this Course to give y: History
y: chief Article of Qualities viz Force

Which will be found to have some Conn:
 in connection & to throw some Light upon y^e
 Others. You must in this, as well as in
 Other Subjects indulge me in giving much
 Theory. For tho' no Body would recommend
 a Wontonnep of Theory less than myself,
 yet I must be Advocate for its Utility under
 proper Restrictions. it is a most power-
 ful Means of exciting us to Experiments
 & consequently ² Knowledge of Facts. Nothing
 will more enable us to detect Fallacy
 & Sophism than a Discussion of Theoretical
 Opinions.

I shall proceed to give you some Advice
 w: Regard to your Conduct in Theoretical
 Inquiries; for I shall not only endeavour
 to make you acquainted w: Chemistry as

applicable to $\frac{1}{2}$ purpose of $\frac{1}{2}$ Physicians. will
 but of the Philosopher also. we shall find other
 likewise that $\frac{1}{2}$ $\frac{1}{2}$ Knowledge of Facts. - I
 & Practice will be considerably enlarged
 by $\frac{1}{2}$ means employed for theoretical of me
 inquiries. But to enable You to follow - I
 me, & to make any Advances your
 selves in Chemical ~~Knowledge~~ Phil Gen
 -phy much preparatory Knowledge - ma
 necessary. - I

Logic is a very necessary part of - I
 introductory Learning. By Logic - I
 many $\frac{1}{2}$ Analysis of $\frac{1}{2}$ human - I
 such as may be found in M^r Locke - I
 excellent Treatise upon $\frac{1}{2}$ human - I
 Understanding. This is not only - I

necessary in Chemistry, but also in every
 other Science where there is Danger of Error.

- I cannot but lament $y: \frac{2}{4} \frac{2}{4}$ Students
 of Medicine in this University are not
 obliged to go thro' certain preparatory
 Branches of Learning: for many of the
 Gentlemen who come here are so igno-
 rant in this Respect, that it is impossi-
 ble for them to make any tolerable pro-
 gress in Medicine. in recommending
 the Study of Logic, if we could venture we
 would recommend it in a particular
 Form, I mean $y: \frac{2}{4} \frac{2}{4}$ Study of Scepticism. not
 an Obstinate Disbelief of every thing. and
 every Fact, but $y: \frac{2}{4} \frac{2}{4}$ kind of Scepticism

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which I Poet calls

"The slow consenting Academic Doubt"

The most common Error in our Reasoning
proceeds from our assuming false premises.
- these in Natural philosophy and particu-
-larly in Chemistry but he obtains
by Induction. Now we have no Book on

this Subject which I am recommended to you

I shall endeavour to lay down some Rules

for assisting you in your Collection of

Facts. I shall divide these Rules into

Two Heads

1: The Choice of Facts.

2: Mechanical Rules concerning the manner
of disposing them.

We must collect Facts by putting them

in writing, not Only from Our own
 Experience but from Books. all Facts
 which we find in Books [&] do not deserve
 a second Reading must be transcribed
 into Our own papers. but then [&] greater
 Caution is necessary to collect none but
 true Facts, for many writings especially
 of the Alchemists contain nothing but
[&] most palpable Falshoods. These Fallacies
 are considerably owing to [&] Difficulty of
 making nice Experiments, & of applying
 our Senses to [&] Examination. Thus [&] Danger
 of making Other (w: has [&] Object of [&]
 Chemists Attention ever since [&] Year 1732)
 has never been Abviated till within these

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two years. Again Dr. Arbuthnot some
time ago settled $\frac{1}{2}$ Heat of $\frac{1}{2}$ human
Body at 82° of Fahrenheit: Thermom: but
it has since been raised to 98° or 100° .

Besides Authors are liable to relate false
Facts this mistake. Thus for example Dr.
Geoffrey has told us $\frac{1}{2}$ Pot: Alkali has
a stronger Attraction to acids than Al:
corbut Lactis, whereas $\frac{1}{2}$ contrary is
now found out to be true. You must
be especially upon your Guard against
such Facts as are deduced from Theory. For
when Macquer says $\frac{1}{2}$ Salt is a Composition
of Lact and water, he does not assert it from
his own Experience, but from his Theoretic

Opinion. he again affirms upon the same authority that Metals Sub: are for: - void of a tritifiable Earth & Phlogiston, which from Experiment you will find to be false.

The concurrent Testimonies of a great Number of Authors must surely have considerable weight, but even here we are liable to Deception, since Facts have been received as Truths from a Series of Authors implicitly, many of which when put to $\frac{2}{4}$ Test of Experiment have been found to be false.

Microscopical Observations are always to be in some Degree distrusted. for instance Lovenhock's Discoveries concerning the

Globules of Blood have long been received
as Spherical, but M^r. Senac says they are lenticular
& D. Haller that they are Spherical.

All Facts ^{ch} w: are said to be universal
are likewise to be suspected. General
Principles are certainly very necessary, but
at the same time very difficult to be esta-
-blished, & always to be received w: Diffi-
-culty. Thus Effervescent mixtures have all been
supposed to produce Heat, but we know
that some of them produce Cold.

We are very liable to mistakes in ascri-
-bing Causes for Phenomena on a Sup-
-position that certain Circumstances al-
-ways produce certain Effects. I g. Air
producing this a great Degree of Heat was
long pronounced to be deleterious to Animals.

even After it was reduced to its ordinary
 Temperature, but this is a mistake, for
 Air passing thro' a Tube that is red hot is
 not rendered ^{un} fit for Respiration, tho' it be-
 comes highly deleterious after passing thro'
 burning Bodies.

Authors are sometimes mistaken in
 assigning One Cause for an Effect which
 several conspired to produce. Thus it has
 been asserted y: y: Freezing of water was
 only owing to Cold, but water in its fluid
 state contains a great Quantity of Air,
 & it must be in a great measure deprived of
 this Air before Freezing can take place.

We find considerable Inconveniences
 from not knowing y: particular Cir-
 cumstances

of Facts, which are then frequently neglected to mention. For example we are told that Brass is formed of a mixture of Zinc & Copper, yet they do not say whether any

Effervescence succeeds ² Mixture. Whether Heat or Cold is produced - whether there is

any separation of parts - whether ² Sp. is

the Gravity is lessened, or increased -

whether there is any alteration in ² Appearance

or taste of this Substance - & lastly whether any

Change takes place in ² Solubility of

either. From these examples we may

conclude that there is hardly any one fact

sufficiently pursued for ² purposes of Phil.

osophy or Arts.

Of the Objects of Chemistry

All ^{or} particular Bodies ^{or} are the
Objects of Chemistry may be referred to
One of these ~~three~~ ^{four} Forms. Viz:

1st Saline.

2nd Inflammable

3rd Metallii

4th Earthy

5th Watery

6th Aerial. except perhaps certain

Animal and Vegetable Substances ^{or} w:
as they cannot ^{be} properly be reckoned

among any of these may constitute
7th Form.

I shall explain by a ~~Diff~~ Definition
of each wherein consists ^{the} Difference of

the six Forms. but you must not expect
my Definitions to be entirely perfect
since I shall only endeavour to give you
such general Ideas of their Names as may
serve our present purpose, & enable
you hereafter to enter upon an Exa-
mination of the Chemical Bodies.

I shall now proceed in y. Order of Nat-
uralists, distinguishing Bodies into Gen-
& Species.

Saline Bodies

These are sapid & miscible w: water. so as
likewise y. next Class of Bodies. we must
therefore have Recourse to a 3rd distin-
guishing Character & that a negative one. Def.
Saline Bodies are therefore sapid. miscible

th w: water and not inflammable.

Inflammable Bodies

The Definition of these is perhaps more perfect, since the Explanation of the Term inflammable is a Definition of the Clasp. Def: — A Body is Inflammable if, when applied to burning Fuel, it also begins (& tho' withdrawn from y^e Contact) continues to burn w: th an obvious Consumption of the whole, or part of its Substance receiving on its surface a luminous vapour called Flame. The Only Exception I know to this Definition is Charcoal, w: tho' properly belonging to y^e Clasp of Inflammables does not produce

any Flame.

Metallii Substances

Def. .. These are shining opaque insipid
Bodies, - not soluble in water - not infla-
- mable - but when exposed to certain de-
- grees of Heat are fusible, & recover after
cooling their Original Texture.

Earthy Bodies

Def. .. These are dry insipid - insoluble in
water - not inflammable or fusible in the
Fire. — no pure Earth is fusible except
w: the Addition of foreign matter. Chemists
however have divided them into fusible &
not fusible. That you may not then
be embarrassed w: these Terms, I shall

add., if fusible they do not congregate
into a: same form as before, but are
converted more or less into Glass.

Watery Bodies

Def. - Water is an insipid, pellucid Body
which in ^e ordinary Temperature of 4°
air is fluid, but when exposed to 32° of
Fahrenheit's Thermometer becomes solid &
freezable, or if exposed to 212° of Heat in the
same Thermom. is dissipated in vapour.

Aerial Bodies

Def. - Air is a thin elastic Fluid. both w:
properties of Elasticity & Fluidity, it pre-
serves independant of all Temperatures.

We shall now proceed to explain the

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Division of $\frac{1}{2}$ several Forms beginning
the Saline. I have employed $\frac{1}{2}$ word
Form, because $\frac{1}{2}$ various Bodies
mentioned are not permanent, but
change their particular Qualities
uniting wth Other Substances or by some
Other Means.

Saline Bodies are either simple
or compound. The simple Bodies are
such as preserve a uniform Appearance
of Texture in $\frac{1}{2}$ most minute parts which
we can examine. The term Simple is
also applied to $\frac{1}{2}$ principal Ingredients
of a compound, altho' some of these
Ingredients may perhaps be resolved

into Others w: ^{are} composed of them. These Bodies
are called Compound w: ^{are} formed of
Parts possessing different properties.

The Simple Salts are either Acid or Alkali.
Acids have a peculiar Taste called sour,
changing Syrup of Violets or Other blue vegi-
table Juices into a red Colour.

Alkalies are sapid, soluble in water, offer:
versing when combined w: ^{the} Acids & changing
the blue Colour of vegetables into a green.

Acids are the vitric, Nitrous, Muriatic,
trifluoric & vegetable so called from ^{the} Substan-
ces which usually afford them. There may
be other Species of Acid, but these mention-
ed are most generally known.

Alkalies are of two kinds Only viz

Fixed, and volatile. The former have very little Odour, & will sustain a considerable Degree of Heat without Disipation. The latter emit a very pungent Odour, and readily exhale in a very gentle Heat.

Neutral Salts are formed by a mixture of Acid and Alkali in a certain proportion. I have been called two Salts Salvi as composed of two Salts. The term Neutral applied because they possess Properties of neither Ingredient before mixture, but are a tetium quid. Thus Nitre which is a neutral Salt composed of Nitric Acid, and fixt Alkali does not effervesce with the same Acid, nor change its colour to violet red or green.

The vitriol is an example

a Metallic, and Alum of an Earthy
 Salt. - Maquer very impropely calls
 Alum a neutral Salt, because it is not
 composed of an Alkali, nor are ^{the} properties
 of its Acid changed. for Alum applied to
^{the} Symp of violets changes its Colour
 to a red.

Inflammable Bodies. of these there

are not so many Species as we might
 at first sight suppose. Their Inflammability
 generally depending upon some parti-
 cular Ingredient. Thus if we extract ^{the}
 Oil from wood - the Sulphur of Pitcoal,
 or the Alcohol of wine, the Residuum of
 these several Bodies will become incap-
 able of Inflammation, & perhaps to these three
 Forms of Oil, Sulphur & ardent Spirit we

may, almost without exception refer
 Inflamability of all Bodies. These three
 Forms are again supposed to depend
 upon one simple Phlogiston to which
 4. Inflamability of all Bodies
 & even ~~now~~ are chiefly to be attributed.

Oil

This is properly of a fluid Form, except
 when it is coagulated or entangled by
 4. Interposition of some other Body. I shall
 therefore define it to be an inflammable
 not miscible with water.

Sulphur is a dry solid
 inflammable Body not soluble in water.

Ardent Spirit is an inflammable
 fluid readily miscible w: water.

Pils are of three kinds viz: Animal,
Vegetable, and fossil.

The Animal & Vegetable are subdivided
into expressed, Essential & Impermeable.

The Form expressed is by no means proper
or universal. for many of 4 Pils called
~~Expressed~~ Essential may likewise be
obtained by Impression. we shall therefore
define 4: Expressed Pils to be insipid, ino-
dorous, and not soluble in Ardent Spirit:
to those belong Fats, Gums & Wax.

Essential Pils have an acid Taste -
are soluble in Spirit of Wine, and retain
more or less of the Taste and Odour of the
Subject from which they are extracted.
Essential Pils are very generally tho' not

altogether peculiar to γ : Vegetable King-
-dom, for γ Animal Substances Exactor
 & much are of this sort: to these Oils
 may be referred Balsams & Resins. These
 do not differ but in consistence; for when
 Balsams become indurated by exposure
 to γ sun or air they are called Resins. The
Essential does not exclude all the
Expressed Oils, for the Expressed Oil of
Maui (so called from γ Method by which
 it is Obtained) retains γ Taste and Odour
 of the Subject from which it is extracted,
 is therefore with γ : strictest propriety an
Essential Oil.

Impurematis Oils are acid & soluble
 in Ardent Spirit. They do not retain the

Taste nor Odour of γ : Subject from which
they are obtained, but acquire a peculiar
burnt smell called Impyreuma, & hence
their name. to this Head belongs Tar.

Fossil Oil of this there is but one Species
called by γ : Naturalists Naptha ^{ch} is
very clear and volatile. When it is become
less pure it is called Petroleum, when
thick like a Balsam it is called Piselon
or Barbadoes Tar. when hard of the Con-
sistence of Resin it is called Asphaltum
or Bitumen Judaicum. This Oil may
be distinguished from γ & expressed by its
Taste and Odour, & from γ & essentially
Impyreumated by γ : peculiarity of its
Taste and Odour ^{ch} w: can only be learned by

Experience, we may therefore define it
to be an Oil of a peculiar Taste & Odour
not readily soluble in Ardent Spirits.

There are various sorts of inflammable
which have been called Bitumens, but
the term Bituminous, cannot be properly
applied to any Bodies, except those which
owe their inflammability to soft Oil.
to the Head of Oils belongs Ether which
is an oily Fluid extremely inflammable
volatile, and of a peculiar Odour & Taste
not to be met with in any other Body, and
not miscible with water.

Sulphur is of one kind only, called
England Brimstone, but in Latin it

it distinguished by γ Epithet Minerale,
 to distinguish it from an inflammable
 principle called by γ Latent French
 written Sulphur.

Ardent Spirit. The word is frequently
 applied w. γ almost in propriety to the
 kinds as Sp. of Nitre Vitriol etc, & even
 to such of γ Essential Oils as are of very
 great Finicity as Sp. Ferubintose. now to
 avoid Confusion we ought to apply γ
 Term only to such Spirit as is Obtained
 from various Substances, w. ^{ch} in its purest
 State is called by γ Chemists Alcohol.

Metallic Bodies.

To the former Definition of them we may
 add γ they are Bodies of γ greatest Speci-
 = fix

Gravity in nature. They are divided into
Metals, and Semimetals.

The Metals are { Gold, Silver
Lead, Tin,
Copper, Iron
& Quick-silver.

The two first of these are called noble
perfect. the five last Base or imperfect
- This Distinction has arisen from
extraordinary Resistance w: ⁱⁿ former
make to ^{the} action of Fire & Air. it has
been supposed ² Gold could bear $\frac{2}{7}$ more
intense Heat without being changed
but later Experiments discover ² in the
Focus of a large burning Glass Gold may
be quickly destroyed. Gold & Silver however
have both been found to withstand ²
of a large Glass-House Furnace many

weeks without any sensible change.

Dr. Boerhaave averred ² y: if any Body could be of equal Specific Gravity it w^d: possess all Other Properties of Gold. but this is also found to be a mistake, for Platina which has none of y^d Properties of Gold is of equal or perhaps greater Specific Gravity.

I have added Quick-silver to y^d Metals because it is found y: under a certain Degree of Cold it becomes ductile, malleable & solid, and these properties of Ductility & Malleability distinguish a Metal from a Semimetal.

The Semimetals are { Zinc - Antimony
Bismuth - Arsenic
Platina - Cobalt
Nickel.

These are distinguished from ² Metals
by their friable texture. but Zinc having
been found to retain some Degree of
Malleability has given Occasion for
- How to divide Metal: Sub: into Malle-
- able, Semimalleable & friable.

Naturalists have long been doubtful
in w: Clap to place Arsenic. Dr Boerhaave
enumerates it among y: Sulphurs. but
now we know y: y: Substances to which
y: name has been applied have a Metal
matter for their Basis.

Metal: Sub: are generally found
a State of Ore. is blended with
th: Other Bodies which most frequently are
Sulphur, Arsenic or both. When these

2^d united w. Earthy Matter, ~~thus~~ as to form
a heterogeneous Aggregate, such Ones
are said to be inherent in Matrices.

Earthy Bodies

These are divided into Absorbent - Crystalline - Argillaceous & Fatky.

Absorbent Earths are very improperly
called Alkaline, because they do not pos-
sess any of 4th Qualities of Alkalies, ..
except that of destroying Acids. 4th Term

Calcareous is also very improperly ap-
plied to them, because they are not all
convertable into Quick-Lime. These
Earths are soluble in Acids.

Crystalline Bodies are not at all
acted upon by Acids. - they are friable &

of such Hardness as to strike Fire with
Steel. These are γ : Substances com-
monly employed for making Glass
by means of fixt Alkali ^{ch} renders
them fusible. From this Circumstance
they have been improperly called Vitres.
-cent: for without γ : Addition of an

Alkali they are no more Vitrescent
Other Earths, and indeed all of them
proper Addition become vitrescent.

Besides γ : Mountain Crystal, where
the Earth took its name, every kind of
Precious Stone, Flint or Sand belong
to this Class.

Argillaceous Earths are not readily
or Obviously soluble in Acids. They are

not hard eno to strike Fire w. Steel. if
 broken down & formed by water into a
 Paste. they become viscid & ductile. This
 Paste exposed to ² Fire acquires very
 great Hardness. These Characters are
 sufficient to distinguish ² Argilla-
 cious from ² Other Classes of Laths.
 But we may also add ² they absorb
² water w. a great increase of Bulk.

Under the Head of Laths I comprehend
 all those Substances called Stones: Mr.
 Beameur thinks he has found an au-
 : rate Distinction between Laths & Stones
 viz: that ² Laths swell and Absorb water;
 but this a property of ² Argillaceous only.
 - in my Definition of Argillaceous

Earths, I have said ² 4: they are not
 -visibly soluble in Acids, or Au^t: of some
 late Discoveries by which we are ~~in~~ some
 that by very strong Acids under a certain
 Management, they may be resolved
~~into~~ ² 4 crystalline & Absorbent, so ² 4 we are
 wrong in enumerating four kinds of
 simple Earths.

Falky Earths are found disposed in
 thin plates or Fibres. they suffer no change
 from ² 4 action of Fire or Acids, neither
 they become viscid or harder when made
 into a Paste. of this Clasp is ² 4 Asbestos
 is composed of Fibres ² 4: by proper M^{an}
 -agement may be made into Cloth
 or Paper. these must be freed from Filth by

and old writing by burning instead of washing. Dr. Brookman a German has published a book upon ²Asbestos, & a copy printed on ²subtane paper presented to a German Prince.

Gypseous Bodies are not soluble in acids, nor yet hard eno to strike Fire wth Steel.

When moist wth water they do not become

ductile or viscid, but acquire a stony hardness,

exposed to Fire they fall to powder w^{ch} has

not ^e Properties of Quick Lime. These

Bodies are disposed in Lamina or Fibres,

& have been clasped among ²Earths, but

they are undoubtedly saline substances

commonly called Selliletes w^{ch} are formed

by a species of Calcareous Earth & vitri-

olic

Liquid.

Of watery Bodies

There is but ^{one} species of water perhaps
in nature of which we have already
given a general definition. we are
able to examine this perfectly pure

Other matters. When water is insipid
& without odour it is called Common
- But when it issues from y^e Bowells
the Earth so strongly impregnated with
foreign matters as to acquire a Taste
& Odour w^{ch} are Obvious to our sense
it is then called Mineral.

Naturalists have commonly confined
themselves to y^e 5 preceding Lemos. In

hither to pursue their plan, but now I shall venture to add a 6th the Aerial.

Aerial Bodies

Air wherever it is met with in a separate state is always Elastic. Its particles have a power of repelling each other. I think there is some Reason to suspect that Air is of two distinct Species, which I shall call Common & Mephitic. The former is indispensably necessary to the support of Life of Animals & support of Flame. whereas the latter is extremely deleterious to Animal Life & suddenly extinguishes a Flame applied to it.

The Distinctions w^{ch} I have made between the two Fluids Air & water are

sufficiently accurate. we may however
 add $\frac{1}{2}$ water is very nearly incompressible
 and is only capable of lateral motion
 Gravitation to $\frac{1}{2}$ Center. whereas Air
 a very Elastic Fluid compressible in
 proportion to $\frac{1}{2}$ Force applied, and
 parts also by repelling and expansion
 each other quoquoque.

Now to conclude this Subject of $\frac{1}{2}$ Chemistry I must observe, that $\frac{1}{2}$ particular Character of Bodies which we have
 given are not sufficiently accurate. that
 indeed can we expect Definitions to be
 quite perfect, since $\frac{1}{2}$ Bodies to be defined
 are unsteady in their Qualities. Thus
 we find $\frac{1}{2}$ water may be converted

into earth or vapour - Air may loose
its Elasticity and become fixt that
Quicksilver may be rendered solid, &
Gold itself which hitherto has been looked
upon as permanently fixt, dissipated in
Flame by $\frac{2}{3}$ Heat of a Burning Glass.

We shall now add some general Ob-
servations on the Objects of Chemistry.

Many Philosophers have thought $\frac{2}{3}$ Matter
was divisible ad Infinitum. Others suppose
that there are Limits set to $\frac{2}{3}$ Divisibility
of Matter, at least by any powers in our
System. The following Argument takes
from $\frac{2}{3}$ Appearance of Nature is not un-
favourable to this Hypothesis. we observe
 $\frac{2}{3}$ Animal and Vegetable Bodies continue

to perish & to be again renewed. Their
 Destruction as far as we can see depends
 upon a Separation of these parts. now if
 ultimate particles of Bodies are liable
 to Change and Division, we should observe
 a proportionable Change in γ Bodies
^{or} ψ : they constitute: whereas we find that
 Animals & Vegetables have continued
 γ : Creation perhaps to succeed each other
 under γ : same Form & Appearance.
Isaac Newton illustrates this Opinion
 any Example from γ : works of Art. if
 an Arch of a given size be built
 Stones properly adapted to it, it will
 be difficult to destroy & again rebuild
 provided γ : Stones remain unchanged

but if the stones by any means become
 altered either in shape or magnitude, it
 will be impossible to produce an Arch of y :
 same size precisely as y : former out of
 such materials.

To consider therefore y : Objects of Chemistry
 more generally we must look upon them
 all as Corporal Substances w^{ch} poss^{ess} par:
 ticular Properties. These are either Elements
 or Mixts.

Elements or Atoms as they were styled by
 y : Greek Philosophers are y : minute par:
 ticles of matter w^{ch} are no ways changeable
 or divisible by any powers in our system.
 These elementary parts of matter are of
 different kinds and Quality; for if the dis:
 =ple

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Elements were all of One kind there could
be no Mixts in Nature, but every
Mass of matter would be a simply
-gregate. Mixts therefore are formed of
or more Elements. These Atoms in a
separate State are not Objects of our sense
- Chemists however have occasioned much
Confusion, by calling $\frac{1}{2}$ most minute
parts of matter $\frac{1}{2}$ can be examined by
human Art Elements, whereas Mixts are
perhaps $\frac{1}{2}$ most simple Bodies w^{ch} we can
possibly examine. it has therefore been
thought necessary to divide Elements into
1. Physical otherwise named Atoms.
2. Chemical, commonly named the Principles.
The former of these are rather inferred than

demonstrated, & perhaps when mist they
 often evade our senses. we shall illustrate
 this by the following example. a Grain of
 Musk will perfume every part of a large
 Room; that is every Portion of Space in y:
 Room will be filled w: th odoriferous parti-
 cles, and this will continue for several
 Days without any sensible Diminution of
 the Musk either in Bulk or Weight. now we
 cannot suppose y: these particles are phy-
 sical Elements, but rather that they are
 composed of two or more of these, notwith-
 standing their minuteness.

Dr. Stahl & his Followers have consid-
 ered Mists as composed of simple Elements.
 These have been called also secondary

Principles. two of these mixt form a Compound. two or more Compounds a supercompound. two or more of these form a supercompound &c.

There is a Foundation in Nature for simple Terms, but I shall not adhere to them in writing this Course, because it is extremely rare that we can determine the exact Degree of Composition which takes place in any Body. This becomes more uncertain in perhaps all Objects that are Obvious to our Senses are mixt or compounds. I shall therefore use the Term mixt or compound for every Body which is divisible into parts of dissimilar Qualities. —

all sensible Bodies may be considered

as Mixts, that may be resolved into con-
stituent parts, or as Aggregates that
may be divided into integrant parts.

The Resolution of the parts of a Mixture
implies a Chemical, and $\frac{2}{3}$ Division of the
parts of an ~~Integrant~~ Aggregate a Mecha-
nical Operation. to illustrate our Ideas
of these Terms let us take the following
Example. Nitre considered as a Mixture
may be resolved chemically into its two
constituent parts Acid and Alkali, when
no Appearance of $\frac{1}{3}$ Neutral will be left.
Again we may consider a Mass of Nitre
as composed of Particles containing such
a Proportion of Acid and Alkali, as that
each particle shall be a perfect Neutral,

such Particles are called $\frac{1}{2}$ Integ: parts
 i.e. parts w: if united into a collective
 would form a perfect Nitre. if therefore
 Portion of Nitre be reduced by mechan-
 ical means to parts of such minuteness
 as $\frac{1}{2}$: any further Division would cause
 separation of its constituent parts and
 Alkali, the Nitre may be then said to be
 divided into its integral parts. and the
 aggregate may be looked upon as an Unit
 to any Number of Individuals or Integ:
 Parts.

To distinguish an Aggregate from a
 Mixt. it is eno to know $\frac{1}{2}$ Number of
 parts of their Connection. we must at
 $\frac{1}{2}$ $\frac{1}{2}$ parts of $\frac{1}{2}$ former are all perfectly mixt.

While those of the latter are dissimilar;
 - yet even this is not absolute, for when Gold
 is intimately dispersed thro' a Stone the
 Mass must be considered as an Aggre-
 gate, tho' it contains various parts.
 we may likewise say y^d in Order to
 form a Mist, the constituent parts
 should be perfectly blended wth each
 Other, as we say per minima.

This much has been said to enable
 the young Student fully to comprehend
 the meaning of the Terms, & to establish
 distinguishing Characters, whereby we
 might know w^h are and w^h are not Che-
 mical

Operations. The Division of $\frac{2}{3}$ parts
 of Aggregates is Only reckoned Che-
 -mical when particular Methods are
 employed.

W. Benelle confines $\frac{2}{3}$ Operations
 of Chemistry to $\frac{2}{3}$ Resolution & Com-
 -position of Bodies, but this is not
 sufficiently extensive. in $\frac{2}{3}$ Sublim-
 -tion of Sulphur for example no Resolu-
 -tion or Composition takes place, & yet no
 Body will deny that this is a Chemi-
 -cal Operation.

D. Atthal & those of his School have
 considered Bodies as Mixts or Tests.
Mixts he considers as Above described

But he does not call Bodies Texts tho:
 if they have peculiar Properties
 arising from their Texture & Arrange-
 ment of their Parts. include Antimony
 the Parts are disposed in Lines resembling
 needles: hence we see a peculiar Pro-
 perty arising from a certain Arrange-
 ment of parts. a Tube of Lead from
 its Arrangement of its parts is what we
 call a Text, or as Others have termed
 it an Organic Body: but Glass wood
 or any other metal &c would be capable
 of receiving the Form of a Tube as well

as Lead; therefore γ properties of Text
 depend upon γ general Properties
 of Bodies. and consequently are not
 γ Objects of the Chemical but of the
 Mechanical Philosophy.

Of the Operations of Chemistry

We now proceed to a general view
 of the Operations of Chemistry. in ² y:
 presentation of this Subject I shall en-
 deavour to make you acquainted w:
^{2d} y Terms relating to y Operations, and
 general Rules for y practice of Chemis-
 try: together w: an Introduction to y:
 Theory of Chemistry - of Chemical Op-
 erations and y: Chemical properties
 of Bodies. I shall begin by laying
 down y: following fundamental Pris-
 ciple

To w^{ch} perhaps there are very few ex-
 ceptions in nature viz: — That
 all $\frac{1}{2}$ Changes of $\frac{1}{2}$ Qualities of
 Bodies produced by Chemistry are
 all produced by Combination and
Separation. under which Terms
 comprehend Refraction & Condensation. This is proved by Induction, &
 may be rendered very probable a priori.
 To illustrate this Proposition I shall
 mention $\frac{1}{2}$ process for decomposing and
 again combining $\frac{1}{2}$ constituent
 parts of Nitre, and to this Instance
 I shall occasionally refer during the

part of $\frac{1}{2}$ pound. Nitre applied to burn-
 ing Lintel is decomposed, i.e. its Acid
 flies off by $\frac{1}{2}$ Deflagration. & $\frac{1}{2}$ Alkali
 remains alone. if to this Alkali a por-
 tion of Nitrous Acid is added an Effervescence
 will take place, and if $\frac{1}{2}$ Acid be exactly
 saturated w: $\frac{1}{2}$ Alkali a substance will be
 deposited ^{or} w: we shall find to be perfect Nitre.
 This Experiment may be repeated ad
 infinitum by deflagrating $\frac{1}{2}$ new formed
 mass of Nitre, and then by adding
 fresh portions of Acid to $\frac{1}{2}$ Alkaline Re-
 siduum. now let us examine $\frac{1}{2}$ pro-
 portions of $\frac{1}{2}$ constituent parts of Nitre,
 & then $\frac{1}{2}$ neutral w: these produce in

Combination.

<u>Acid</u>	<u>Neutral</u>	<u>Alkali</u>
Fluid	Solid	Deliquescent
volatile	Fixed	Fixed
Corrosive	Mild	Corrosive
Heating	Cooling	Heating
Quenching	Excit. Inflamm ⁿ	Quenching.

with
water
with
Fire

The Change of Qualities in these Bodies
seems evidently to depend upon Combination
& Separation; tho' we shall hereafter

perhaps meet w: some Substances where
Qualities cannot be positively referred
to these Causes; because $\frac{1}{2}$ Matter dissipated
or added may not be obvious to our Senses

e.g. From 100^{lb} of Lead 110^{lb} of Mercurius may
be Obtained notwithstanding $\frac{1}{2}$ parts
are dissipated in $\frac{1}{2}$ Operation. here we observe

a manifest Increase of Weight, without
 being Able to discover any Addition
 whatsoever. But if our Proposition is found
 true in 99 Cases of 100. we may be allowed
 to conclude from Analogy y : it takes place
 in the hundredth. Again if there be any
 physical Elements, or indivisible Atoms, the
 Qualities of Bodies must depend upon the
 Composition or Resolution of these; & on
 this Hypothesis our Proposition will be
 founded.

There may be Cases where neither a Com-
 position of discrete, nor of concrete Bodies
 takes place, but only a Change in the
 Position of Parts. E.g. the Mephitic Air
 discharged & absorbed again in y various

Fermentation. yet even here we may observe
a Separation of parts must precede the
Change of their Position. —

From what has been said, the Definition
of Chemistry I formerly mentioned, as
being a commonly received one viz: the
Chemistry is $\frac{1}{2}$ Art of combining & Separ-
-ating Bodies, will appear very proper
but it is too general and not sufficiently
evident.

Having thus endeavoured to establish
our general Proposition, I shall proceed to
make some Remarks upon it as theore-
-m of Chemistry. and w: a view to ex-
-plain $\frac{1}{2}$ better, I shall mention different

Hypothesis concerning ^{the} Origin of the
Qualities of Bodies.

The Peripateticks maintain ^{the} Doctrine
of Substantial Forms. Whence they derive
Qualities of Bodies independant of their
Texture & Combination of their Atomical parts.

^{The} w. Regard to ^{the} Doctrine of Substantial
Forms, it is faulty in this, that it infer^s ^{the}
Doctrine of Qualities. of which as they
relate to physical ~~causes~~ elements we
must be extremely ignorant, for the most
subtle & minute Bodies may be shewn to
be compounds for the most part, & sometimes
perhaps Decompounds.

I think every Experiment seems to be

most favourable to $\frac{2}{4}$ Doctrine of the
 Corpuscularian Philosophers. for from the
 let us examine Nitre and its constituent
 Parts, neither of which we can suspect
 being Elementary Bodies. we find the
 Acid fluid - the Nitre solid - the Alkali
 deliquescent - the Acid Corrosive - the
 Nitre mild - the Alkali Corrosive &c. Now
 we see two Bodies Acid & Alkali produ-
 -cing a tertium Quid differing from
 Both. now supposing $\frac{2}{4}$ Acid and
 Alkali derived their Qualities from sub-
 -stials Forms, can we conceive any Reason
 why these Qualities should not be trans-
 -ferred to the Neutral?
 upon the other Hypothesis we may

Suppose that upon y. Addition of y. Acid &
 Alkali an entire Change in y. Arrange-
 ment of their Parts takes place; from whence
 it is easy to imagin new Properties may
 arise in the Neutral. in short all our
 views lead us to speak of particular Qua-
 lities in the particular Texture of y. Mixts
 in which they reside, unless we can separate
 that part from y. Mixt which gives it its
 particular Quality. for Instance wood is
 an inflammable Body. its Inflammability
 depending upon its Oil, which may be
 separated from it. But this is only carrying
 the Question one step further. for we may next
 inquire from whence proceeds this Inflamm^y

in the Bil? In a Miat however in which
 $\frac{2}{y}$ Qualities of the Ingredients do appear
 we cannot always refer them to $\frac{2}{y}$ Ingred-
 -ents; for Nitre ^{is} is composed of two pro-
 -erfull Antisepticks Acid and Alkali is
 it self less so. Whereas One would surmise
 the Doctrine of Qualities that it should be
 more Antiseptick. It is certainly more pro-
 -bable that $\frac{2}{y}$ Antiseptick Quality of Nitre
 does not depend upon $\frac{2}{y}$ same Quality
 $\frac{2}{y}$ Ingredients but upon $\frac{2}{y}$ particular Com-
 -bination of these in forming $\frac{2}{y}$ Nitre is upon
 $\frac{2}{y}$ particular Texture of the Nitre. Again
 if to a Quantity of the Syrup of Violets
 turned red by an Acid, I added a Quan-
 -tity of the same turned Green by Vol: Alkali

provided $\frac{1}{2}$ Acid and Alkali be sufficient
 exactly to saturate each Other | what will
 be the Result of this Mixture? - will the
 Mixture retain $\frac{1}{2}$ Colour of $\frac{1}{2}$ Ingredients
 & consequently be a Colour compounded
 of green and Red? - no - the Acid &
 Alkali mutually destroying each Others
 Texture, and $\frac{1}{2}$ power by which they acted
 upon the Symp. will suffer $\frac{1}{2}$ Symp. to
 regain its former Texture, and consequently
 its blue Colour which depended upon its
 Original Texture.

I come now in the next place to Observe
 this ~~the~~ Corpuscularian Doctrine has in
 its Turn been much abused. many who

have espoused this Doctrine have imagined
 that y : different Properties of Elements
 depended on y : particular Size & Form
 each, and y : therefore all y : different
 Compounds resulted from a variety of
 Combinations of these Elements; as several
 Squares make a Cube - two Cubes also
 parallelepiped &c. But this Notion is liable
 to many Objections which have given
 Occasion of Triumph to y : Opposite Sect.
 it is not sufficient to suppose a Probability
 of demonstrating y : Existence of ~~such~~
 such Elements or Corpuscles; but before
 Conclusions can be drawn, Demonstration
 must be actually obtained.

We shall adopt a more proper

Scheme to lead us to the Theory of par-
ticular Qualities by considering —

What Qualities belong to Bodies
as Aggregates, or to constituent parts.

What Disposition Bodies have to

unite wth each Other: Thus vitriolic Acid

and fixed vegetable Alkali unite readily

wth water in a separate State; but vitrio-

-lized Tartar wth is formed of these two is

of difficult solution.

The Qualities of Aggregates, and the
modes of Aggregation consist in some measure
between Heat, and the particles of matter.

— it is even probable that all 4^e different

kinds of matter may be reduced to two,

viz: the matter of Heat, or an Elastic
 matter which seems to have a repul-
 -sive power, and y^d kind of matter
 has the power of Attraction, or perhaps
 we might go further, and suppose that
 is perfectly inert.

I proceed now to another principal
 application of our proposition concerning
 the Operations of Chemistry viz: as it
 -lates to the particular Operations.

The Combination of Bodies in Chem-
 -try depends upon Attraction, & this
 y^d only Property I can perceive in Bodies
 which does not depend upon their par-
 -ticular Texture. if we examine the

particular State of Bodies when Attraction takes place, we shall find it to be Fluidity. — Combination therefore depends upon Attraction, & this upon Fluidity, w^{ch} being liquid or Elastic is employed in Solution, Fusion & Evaporation.

The Term Attraction here employed has been y^e Foundation of Indless Debates among Philosophers. we shall first therefore endeavour to affix y^e precise Meaning that we would have it imply.

Every Tendency that we can perceive in different Bodies to approach each other and then remain in a State of Coherence has been called Attraction, & of this there are several Species. a Stone drop & Iron

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a Right endeavour to make its way
to the Centre of the Earth, and $\frac{2}{3}$ Planets
if not restrained by another Cause will
drop into the Sun. This is called the

Attraction of Gravitation.

The Tendency of a piece of Iron, and
a Load Stone to approach each other is
called the Attraction of Magnetism.

There is likewise an Attraction of
Electricity which may be excited by
various means, as by rubbing Glass
limber - waxed. —

Two Globules of quick-silver upon a
plane, or two Drops of Oil swimming
upon water being brought near each

Other, shew a mutual Tendency to
 unite. w: Tendency is called γ : Attraction
 of cohesion. and this Term we shall have
 more Occasion to employ hereafter. -

With Respect to all γ : Modes we have
 mentioned, the Term Attraction is only
 applied to signify γ : general Fact. This
 is γ sense in which Sir Isaac Newton employs
 γ Term not saying whether γ Fact pro:
 ceeds from some power exerted by
 γ Bodies attracted, or from their being
 pushed together by some external force.
 Some say this Attraction is γ immediate
 Act of the Creator, but this way of rea:
 soning would soon put an end to all
 philosophical Inquiries. Thus when γ :

Properties of the Air were not so well under-
 stood as it present, the established Do-
 -trine of Nature's Abhorring a Vacuum
 gave a considerable Check to ² further
 Inquiries concerning ² Phenomena
² Liquid. — The sense in which we now
 always employ ² Term Attraction in-
 be rather to express ² Operation than
² Modus Operandi.

Chemical combinations depend
 upon ² Attraction of Cohesion. The
 Chemist only puts ² Bodies he would
 combine in a state most necessary for
 the exertion of this Property, w: generally
 takes place in a certain Degree of Con-
 -sistency Only. it seems to depend also

upon y^e surface of 4 parts of 4 Bodies
 in Contact. This notion is favoured
 by a simple Experiment. if you take
 two Hemispheres whose flat surfaces
 are well polished, and press them strongly
 together, they will adhere pretty firmly,
 & this Adhesion will be in proportion to
 y^e smoothness of their surfaces. but we
 have used our utmost skill to give
 two substances a perfect polish, that y^e
 greater number of Parts may be
 brought into Contact, we find ^{y^e} they
 never will cohere so perfectly as when
 a fluid is ~~is~~ interposed. This Circum-
 stance is a further Confirmation of w^d

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hinted at before, is γ : $\frac{2}{3}$ fluidity is γ : only
means of giving γ : Contiguity which is
necessary for γ : Attraction of Cohesion.
- But perhaps this Contiguity is not
 γ : Only cause of Cohesion. There is prob-
ably something else disposing all
Bodies solid and fluid to unite more
or less w: each Other. May not Elec-
trical Attraction serve this purpose?
- I cannot venture at present to discuss
this Subject: those Facts however are well
worth Observation that all γ : Liquids
are acquainted with are non-electric
and all γ : Solids (Metallic Substances)

excepted/ are Electrics & are when they
are as free as possible from wet or
moisture. —

Separation is produced by
Elective Attraction or ² Action of Force.

Elective Attraction is Absolute or Relative.

Single or double. —

Absolute Attraction is when a Body pre-

sented to two Others, attracts ² One but

refuses any Union wth ^{the 2} Other.

Relative Election takes place when a

Body presented to two Others attracts ^{the} both

but ~~refuses any Union~~ has a

greater Tendency to One than ^{the} Other.

as an Example as ² first we may

Take White Camphor, and adding there
 to water we shall find $\frac{1}{2}$ part readily
 dissolved in $\frac{1}{2}$ water, while $\frac{1}{2}$ Camphor
 will remain unchanged. ~~but~~ if in the
 Room of water we add Ardent Spirit
 the Camphor will be dissolved & the
 White left entire. -

we may illustrate Relat. Attraction
 by $\frac{1}{2}$ follow. Experiment. To a portion of
 Camphor united w. th Ardent Spirit let
 water be added, the Spirit having a
 stronger Attraction to water than to Cam-
 phor, will immediately let fall $\frac{1}{2}$ latter
 unite w. $\frac{1}{2}$ former. A consequence of
 Relative Attraction is, $\frac{1}{2}$ a Body cannot

th be united w: two Bodies at Once, but
th that Only w: it Attracts most strongly,
 provided likewise y: ² Body added a stron:
th ger Attraction w: Respect to One of the
 combined Bodies than they have be-
 tween themselves.

The Effect of Selective Attraction affords
 a very useful method of Obtaining
 Separations, as in y: Examples Above or
 in y: following. Let a piece of Copper
 be added to a Solution of Silver in
 Nitrous Acid, y: Copper having a
 stronger Attraction to y: Acid than y:
 Silver will precipitate it pure to y: Bottom
 and unite itself w: y: Acid. upon y: same

Principles of Copper may be separated by
 the Addition of Iron. —

Single Selective Attraction takes place

When a single Body is employed for
 decomposing a Mixt. E.g. Silver
 separated from Nitrous Acid by Copper

Double Select. Attraction takes place

When One Mixt is employed to separate
 another. as suppose instead of employing

Copper alone for separating Silver from

Nitrous Acid, I had employed a solution

of Copper in Muriatic Acid, then

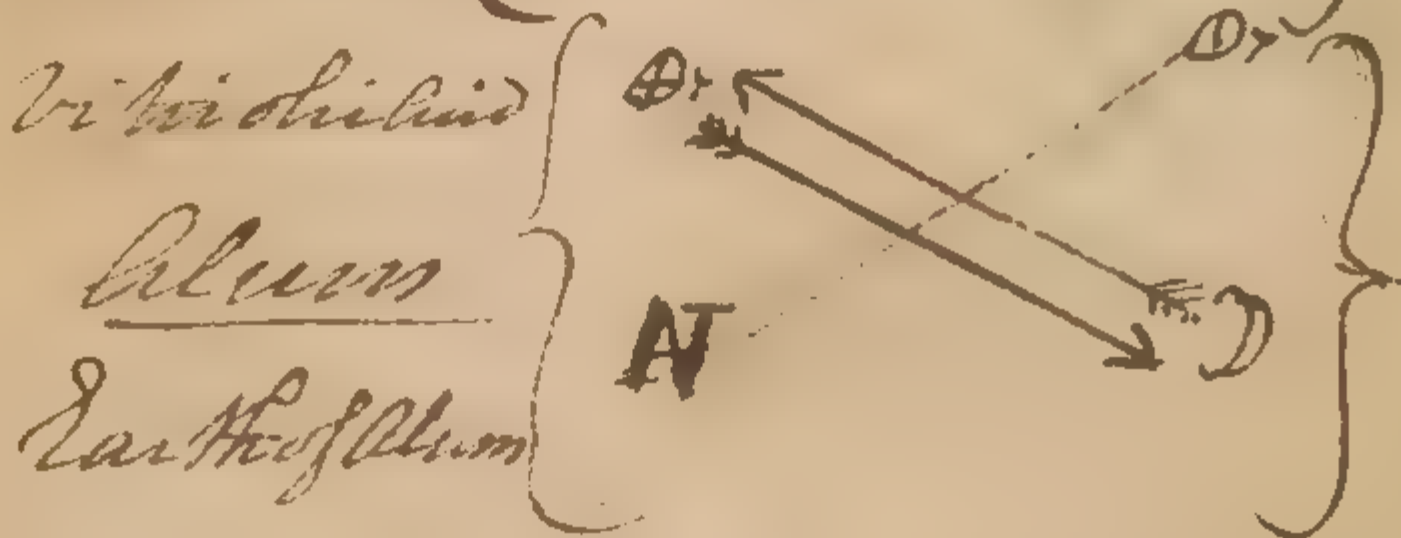
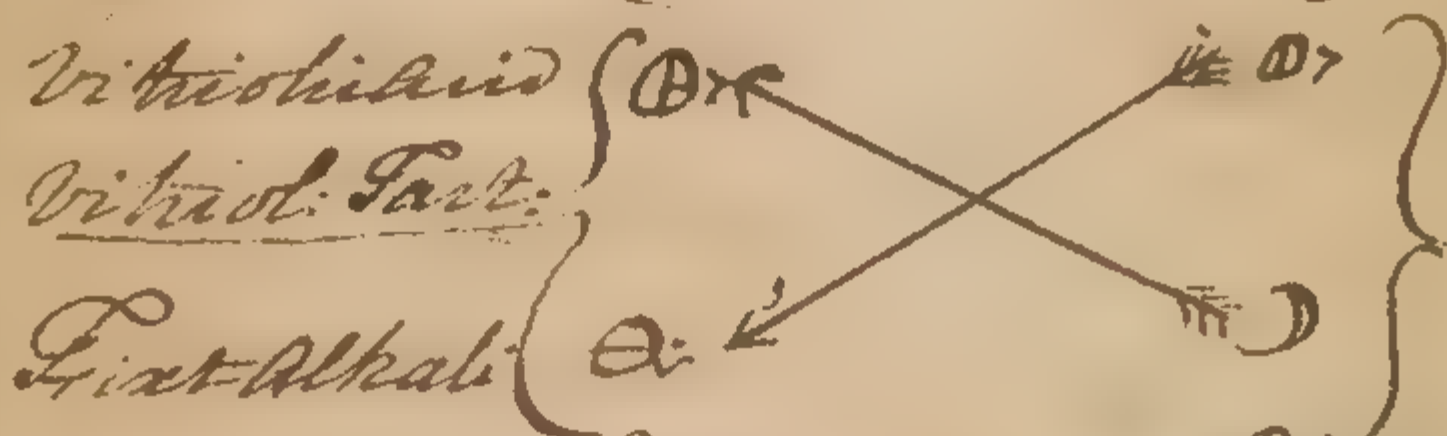
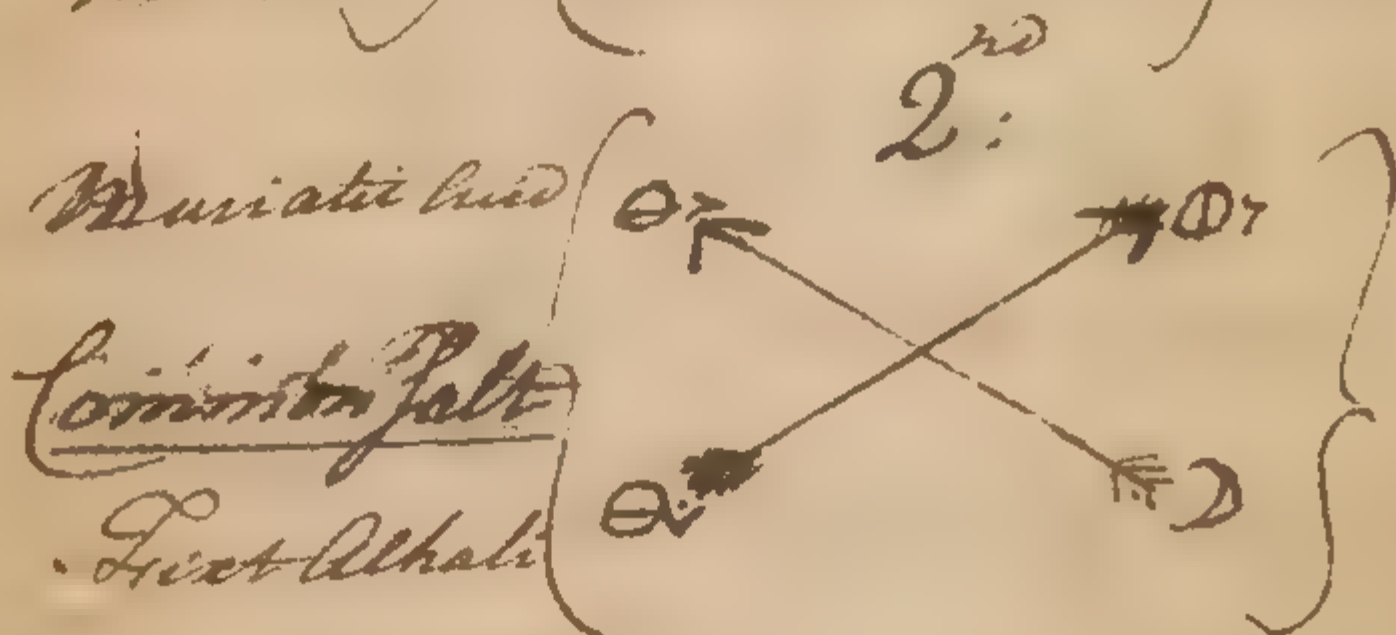
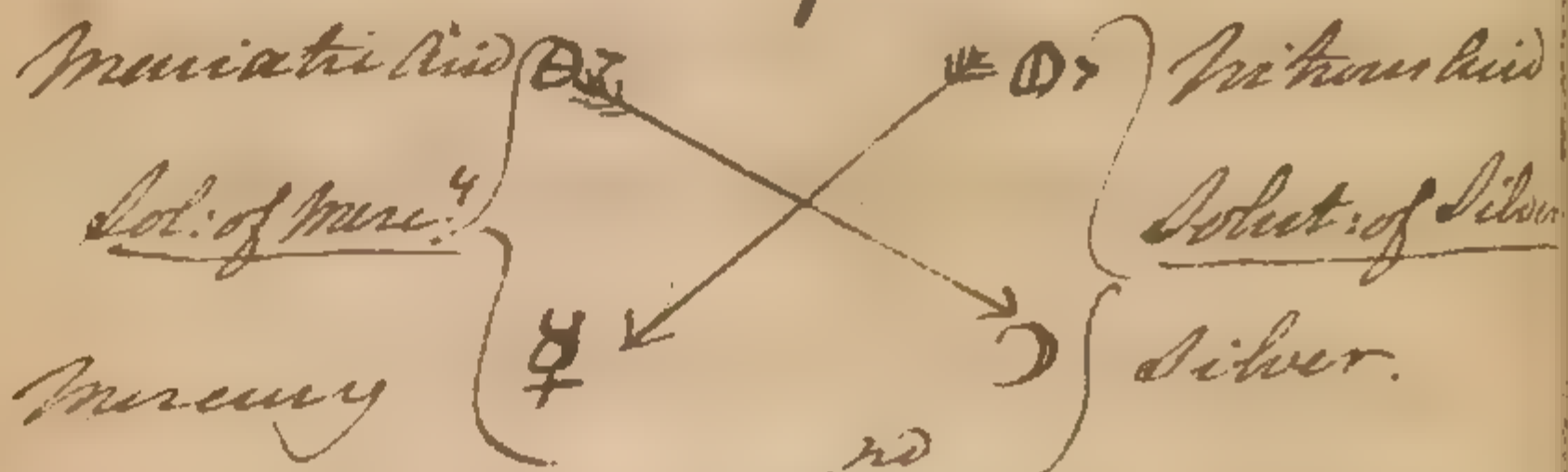
have been two new Mixts produced.

One by separation of the Silver from

Nitrous, and its union with Muriatic

Acid, the other by γ : separation of γ : Copper
 from γ : muriatic, and its union with
 γ : nitrous Acid. I must however Ob.
 serve γ : in all cases when one mist
 is employed for decomposing another;
 two new mists do not arise as in the
 preceding Instance: but this will be best
 understood by considering γ following
 Diagrams, which comprehend per.
 haps all γ : cases of double elective
 attraction.

The four Cases of double Elect. Attractions



The Bodies w^{ch} stand upon y^e same
 side in each Diagram are supposed to be
 united. in y^e first for example y^e Bodies
 on One side denote a solution of Mercury
 in y^e muriatic Acid. and those on the
 Opposite side denote a solution of
 Silver in the nitrous. The Darts drawn
 diagonally from y^e Bodies on Oppo-
 site sides denote y^e matter from w^{ch}
 y^e Dart proceeds attracts y^e to which
 y^e Dart is directed. more strongly than
 y^e Body w^{ch} it is at present united.

Thus (Fig: 1.) the Or attracts D more
 strongly than y^e Mercury w^{ch} it

at present combined, and on y ² other
 hand the O attracts the $\&$ more strongly
 than y ² D ² w : w : it is combined.

Whenever we add two M ia^{ts} whose
 parts have y : same Relations to each
 other as are expressed in y ² two first M ia^{ts}
 a double Relative Attraction will always
 take place between them, w : may be
 thus demonstrated. Let y ² Attraction
 between the O & $\&$ be denoted by a
 that between y ² O & D by b . Let y ²
 new Attraction which takes place
 a mixture between y ² O & D be called c
 & y ² between y ² O and $\&$ be called d .
 is then evident from what has been said
 that c is greater than a & d greater y ²

That is y : Sum of the two new Attractions $c + d$ is greater than y : Sum of the Attractions $a + b$ & opposite μ ento: in consequence of w : an Exchange of parts will take place between y : new Micro Bodies: w : has been said of the first will obviously apply to y : second case.

In Case 3: we cannot always be certain before the mixture, whether a double Elective Attraction will take place, since we do not know y : Absolute powers of Attraction exerted between Bodies, but only their Relations to Other Bodies to prove this let the

Attraction between Or & D in Case 3^d
 be called a , & the Attraction between
 Or & D be called b . let also y : two
 new Attraction^{ch} w : will arise from a
 mixture, be between ~~the~~ Or & D
 the Or and D be denoted by c & d . from
 y : Position of the Darts we know y : c is
 greater than b , and d also greater
 than b . then is $c + d$ greater than $2b$
 But y : Attraction a is indeterminate
 - we only know y : it is greater than b
 but are ignorant in w . Ratio it exceeds
 that is whether a be greater than $2b$;
 can be determined by Experiments

place, in most of ^{ch} w. a is found to be
less than 2b, and consequently a double
lutive Attraction generally takes place
in Case 3^d. —

In Case 4th we cannot determine be-
forehand, whether a double lutive
Attraction will take place, & indeed
this is found by Experiments to fail
much oftner than Case 3^d. — Let
the Attractions of Φ and Ψ Earth of Alum &
of Φ and Ψ be called a and b , and the new
Attraction between Φ & Ψ be called c . we
know from 4th Position of 4th Darts 4th c is
greater than a , and also that it is greater

than b ; but we can determine by
Experiment alone whether a is greater
than $a + b$, ^{ch} w. must be y : Case before
an Electric Attraction can enow. —

To a first y : Chemist in his Studies
Dr. Stahl and Sir Isaac Newton began
Construction of Tables of Electric Attraction
- tions, together w. th their Application; but
M^r. Geoffroy has published One of a considerable
Length, w. ^{ch} ~~should~~ here subjoin
w. an Explanation, had it not been given
already so fully by Macquer in his
- ments of Chemistry. —

I could wish in this place to give a
 Theory of the five Attractions, but y^e Sub-
 ject is so extremely obscure that we can
 only expect to deliver a general view of
 it.

Throughout all nature there seems
 to be an Elastic Repellent Fluid, w^{ch} is
 the Cause of all y^e Phenomena we observe
 in nature, more particularly of y^e various
 States of Aggregation in different Bodies.
 every Body is surrounded by its own pec-
 uliar Atmosphere of this Fluid which grows
 more dense as it recedes from y^e Surface.
 This is Analogous to y^e Atmosphere of
 excited Electricity; which determines Bodies

Once got within its Sphere of Attraction
 to $\frac{1}{4}$ Surface of the Electric Body, it
 is to be observed $\frac{1}{4}$ Bodies thus in Con-
 tact wth $\frac{1}{4}$ excited Body remain some-
 longer some a shorter time in Contact
 wth $\frac{1}{4}$ Body Untill they have got an ab-
 sorption of their own; - then they are
 repelled th till meeting wth some other
 - then they discharge their Electric Atmosphere
 and are again attracted & repelled as before
 - now let us try if from wth has been
 said we can form any Conclusions
 concerning Solutions & Mixtures
 which we can, and are of Opinions
 those Bodies which when brought into

Contact have but one common At-
 mosphere are in a State of Mixture;
 whereas in Solution the particles of
 each Ingredient retain their proper At-
 mospheres, and are still capable of ac-
 ting separately upon Other Bodies ap-
 plied to them. very probably $\frac{1}{2}$ of the
 fixed Air has $\frac{1}{2}$ power of rendering
 Bodies more or less powerful Attractants
 or Repellents; and hence it is perhaps
 $\frac{1}{2}$ birds having the greatest power of
 fixing Air, and by $\frac{1}{2}$ means of procu-
 ring a denser Atmosphere, are universally
 the greatest Solvents.

In all Cases, as we have already

said concerning Attraction in general
 the Lecture depends upon Fluidity
 & therefore also upon Solution, Fusion
 & Exhalation.

I said before that 4. Separation of
 Bodies was produced by two means.

1. By the Active Attraction -
2. By the Action of Fire.

I have finished w. I had to say of the
 former, and shall now proceed to con-
 sider the latter. The Fire separates Bodies
 in consequence of their different Degrees
 of Combustibility, and acts by Fusion, as for
 example: That requires a less Degree of
 Heat for its Fusion than wax. - was a

less Degree of Heat than Lead Lead than
Copper Lead. —

Fire also gives to many solid Bodies
* State of Fluidity which we call va:
pour. According as Bodies are more or less
apt to fly off in this manner they are
more or less volatile. When we by means
of Fire we thus raise Bodies in y: Form of
vapour, the Operation is called Exha:
lation. Hence it appears y: all y: Opera:
tions of Chemistry whether of Combina:
tion or Separation may be referred to
Solution, Fusion and Exhalation.

I shall next proceed to consider these
separately, after having promised some

Something concerning ^{the} manner
in which Fire produces its Effects.

The Action of Fire removes ^{the} Particles
of Bodies further asunder, wherefore

Fire is actually a Repellent power
all ^{the} Operations in Chemistry are per-

formed by this Repelling power and ^{not}
Attracting power, and perhaps we might

say that all ^{the} Operations of Nature as
well as of Chemistry are performed by the

Agents. we do not know any Body in
its utmost State of condensation, nor do we

know any Body that is impervious to
Fire. ^{the} Repelling Elastic Fluid or Air

of Newton is universally diffused thro:
out all nature, and constantly acting as
Repellent power.

The Attractive and repelling powers
are constantly acting in Opposition to
each Other, and yet perhaps depend
upon ^a very same Other acting in
different Circumstances. & it will not
be difficult to admit this if Am Postu:
lation be granted viz: that Inert matter
in a certain Contiguity of its Parts
has a power to diminish ^a repelling
power of ^a intervening Other betwixt
its Particles. This admitted ^a Attractive

power may be entirely $\frac{2}{3}$ Effect of Repulsion

When two Bodies are in such a close
Contiguity as to diminish $\frac{2}{3}$ Repul-
-ling power of $\frac{2}{3}$ intervening Other, if an
Power is applied to render $\frac{2}{3}$ Other
active, the Bodies will also be again
separated by $\frac{2}{3}$ repelling power. Thus
Fire acts on solid Bodies separating
its repelling power their Parts, first brings
them to a State of Fusion, & afterwards
if more encreased dissipating them in
 $\frac{2}{3}$ Form of vapour. if all $\frac{2}{3}$ different
-sorts of Bodies depend upon their
-fixed States of Aggregation, their

Differences again depend upon Other.
 and Other, and Inert matter are here sup-
 posed to be γ : Only matter in nature,
 and γ : latter of One kind Only.

This Theory is not new. You may
 collect it from Newton's own works,
 but more particularly from Dr Bryan
Robinson's Treatise upon γ : Other of
Sir Isaac Newton. it is γ : most plau-
 sible Scheme of Chemical Philosophy,
 will at least check γ : false Theories of
Corpuscularians. but in an Atom
 of this kind γ : Difficulty is to find the
 Cause of elective Attraction, or why

Other does not admit of an equal Union
 w: all Bodies. having said so much
 by way of Introduction. I now proceed to
 a separate and more particular Con-
 sideration of Solution, Fusion & Sublimation

Solution

When a Solid Body immersed in a Fluid
 is diffused equally and uniformly
 thro every Partion of γ : Fluid, so as to
 remain w: it in a fluid Form γ : Operation
 is called Solution.

The Solid Body is called γ : Solvent
 the Fluid in which it is dissolved is called
 γ : Solvent or Menstruum. The former
 Menstruum took its Rise from this Circum-

stance, that y : Ancient Chemists used
 to allow a month for y : solution of a
 Body imagining y : this portion of time
 had a peculiar effect upon y : solution.
 I would use y : term solution in a still
 more extensive sense, and apply it to y :
 mixture of Fluids w: each other, for the
 term is equally proper if y : Original
 to Courpages or texture of y : Fluids be
 broken down, and indeed we find it
 as common to speak of y : solu-
 tion of Essential Oils in Ardent Spirits
 of Camphor. But in y : case of Fluids
 it may be often a difficult matter to de-
 termine w: is y : solvent, & w: is the

Monstrum. The best way of distinguishing them is this: When y : Quantities of y : Fluid are unequal. Let y : Tangent be called y : Monstrum, & y : smaller the solvent. When y : Quantities are equal

we cannot always make a Distinction. Chemical Solution must be distinguished on y : One hand from Diffusion commonly called Mechanical Solution and on y : Other from proper Mixture.

When Bodies Specifically heavier than a Fluid are immersed therein, they will descend to y : Bottom but, y : times of their Descent will be reciprocally proportional to their Specific Gravities. & y : if we drop a Ball of Gold, and another of ~~low~~ Glass, the

Gold having $\frac{2}{3}$ greatest Specific Gravity
 will descend in the least time. But a Body of
 any Specific Gravity may be suspended in
 a Fluid by Division; for if a Body be divi-
 ded into a number of parts, $\frac{2}{3}$ Quantity
 of matter of Specific Gravity of each of
 those parts will decrease in a greater Ratio
 than their Magnitudes or Surfaces. Thus
 if a solid square Body contain 16 equal
 parts, or Cubic Feet, the superficial Con-
 tents of each of these parts will be one square
 Foot, and this solid contents equal to 1
 Cubic Foot. From this it is most evident
 that $\frac{2}{3}$ Surfaces of these parts taken
 separately are exceeded by $\frac{2}{3}$ Surface of
 $\frac{2}{3}$ Mass before Division as 4:1, whereas $\frac{2}{3}$

solid contents decrease in $\frac{1}{4}$: greater
 ratio of 16 to 1. The Suspension of Galls in
 water when it is broken down or divided
 into parts sufficiently minute, depends
 upon $\frac{1}{4}$: foregoing principle. This is
 I call Diffusion, and w: Others call
mechanical solution, by way of Distinction

from Chemical, which is $\frac{1}{4}$: intimate
 & minute union between $\frac{1}{4}$: parts of
 solvent and Meas-truum which we may
 illustrate to you by $\frac{1}{4}$: following Experiments

If One Grain of common salt be
 dissolved in several Gallons of water,
 a last portion of this solution w: we
 can examine added to a solution
 of Silver in Nitrous Acid will discover a

much γ : Appearance and Effects of the
 salt, as if the whole grain had been dissol-
 ved in a few Drachms of water. it is
 however very difficult sometimes to dis-
 tinguish between Mech:^l & Chemical
 solution. The former will sometimes
 pass thro a Filter without sediment,
 & has generally less than a distinguish-
 ing mark between them. The most
 Obvious Distinctions are, γ : Chemical
 solutions are transparent, Whereas
 γ : Mechanical for γ : most part have
 a turbid Appearance, or that γ former
 are permanent, the latter only tempo-
 rary, or that γ : former takes place

Only by bringing y. Bodies into a proper State of Contiguity. Whereas y. latter require Agitation, yet perhaps none of these means of judging are entirely unexceptionable. —

Again, Chemical Solution strictly speaking may be distinguished from ² w: we call proper Mixture by several Circumstances. In Solution there happens no other Change of Properties than the Reduction of the Solvent to a fluid Form, or rather the Division of it into its minute integrant parts, as happens in the Salt and water. In proper Mixture the Bodies do not retain the Properties they had before such Mixture, but the

Result is w. we call a tertium quid, or
 a third substance differing from those
 Ingredients w. compose it, & possessing
 new Properties. an example of this we
 have in the production of a neutral
 from an Acid and Alkaline salt. there
 may be however some cases wherein
 it will be difficult to distinguish them
 by this mark. in solution there is no
 generation of Heat, but I think that no
 mixture ever takes place without a
 generation of Heat. Another Distinction
 may be that two Bodies only can be
 united at y. same time (w. was observed
 where we mentioned Electric Attraction)
 whereas in solution more than one Body.

may be united w: a fluid at $\frac{1}{4}$ same
time. I am not certain of $\frac{1}{4}$ ^{series}
-sality of this Remark, but in general
it seems to hold true. —

The power w: ^{ch} Minerals have of
dissolving their Solvents is limited as
well in solution as proper mixture.

Thus a Quantity of water will take up
half its weight of Glauber's Salt, $\frac{1}{6}$
of Nitre, and $\frac{1}{3}$ of common Salt. ^{be}
Whatever is added of $\frac{1}{4}$ Above mentioned
Salts to water, more than $\frac{1}{4}$ proportion
specified this additional Quantity will
fall unchanged to $\frac{1}{4}$ Bottom. When
Fluid therefore has dissolved $\frac{1}{4}$ greater
Quantity of a solvent possible, that

is said to be saturated. in solution a
 saturation is generally effected by the
 solvent. with Regard to proper mixture
 saturation takes place when $\frac{1}{2}$ bodies
 are combined in such proportion as to
 form a perfect neutral, but is not con-
 fined to the solvent, but may be effec-
 ted by $\frac{1}{4}$ solvent or menstruum Alter-
 nately. 2: G. if to Symp. of Violets be
 added an Alkali the colour is chan-
 ged to a green; if to this Compound
 a Quantity of Acid be added exactly
 sufficient to saturate the Alkali or in
 other words to form a neutral, $\frac{1}{2}$ Symp.
 will immediately recover its blue colour,

but if again you add to this saturated mixture, a quantity of acid or alkali the Symp will be changed terminally to a red or green as the one or other predominates. —

The vessels commonly, & most properly employed in solution are matrasses and Bolt-heads. When a Matrap is closed by another smaller & inverted, and joined to it, it is called a Circulatory Apparatus or Pelican. The former of these terms is applied, because vapours arising from the lower vessel are condensed in the upper and return again to the lower by a continued

Circulation. The best substance for making these vessels is Glass, because it is least liable to be corroded by any Menstruum, and at the same time the proper management will sustain a very great Degree of Heat. This Quality is much increased by a Spherical Figure, and uniform thickness of 4 Lines.

The Operation of Solution may be expedited by several Means 1. by the Division of the Solvend. it is evident that 4 Menstruum can act at the same Instant of time upon those parts of the Solvend only which are exposed to it, or in other words on its Surface. now if

by any means y : number of particles
 immediately exposed to y : menstruum
 any given Quantity of the Solvent, be
 increased, or w : is y : same, y : Surface
 of the Solvent be increased, it will be
 evident that y : time w : y : Menstruum
 will require to dissolve this given Quan-
 tity of the Solvent, must be propor-
 tionably lessened. for y : Menstruum
 act as forcibly upon y : greater as the
 smaller Surface, and consequently
 a given time produce a greater
 -fect. That this Increase of Surface
 of the parts exposed may be effected
 Division will be obvious from the
 principles mentioned on y : Subject
Mechanical Solution. 2^{dly}

only by the Agitation of the containing
 vessel: the chemical solution is per-
 formed merely by adding the Bodies to
 each other; yet we may expedite it by
 Agitation, because by this means a qua-
 ter portion of the Menstruum is app-
 to $\frac{1}{4}$ of each and vice versa at $\frac{1}{4}$ same
 time. E.g. Sp. of wine poured gently
 upon water will swim on $\frac{1}{4}$ surface
 without any Appearance of Union.
 But one Shake of $\frac{1}{4}$ Vessel will so in-
 timately diffuse them together, they
 they will remain united for Years. if
 $\frac{1}{2}$ of Salt be added to a Gallon of
 water. it will not dissolve in as

considerable time, but if γ be fully diff
 agitated it will dissolve in a short time. Obs
 Mon: Lagnard has invented a method for
 for promoting solution. I suspect for γ
 γ : advantages arising from it will not be
 be so great as he imagines. The one γ : wa
 advantage will be γ : we may dissolve
 Bodies in γ Cold, which is a matter
 of great importance, as that change
 considerably γ : Properties of many Bo
 = diss.

3^{rdly} By the Application of Fire
 when I was treating of saturation
 Observed γ : any particular Menstruum
 would only saturate a certain por
 = portion of the solvent, & γ varying in

different Bodies. I ought however to have
 observed $y: \frac{1}{2}$ Temperature of Menstruum
 to be precisely $y: \frac{1}{2}$ same in every Experi^m.
 For $y: \frac{1}{2}$ power of a Menstruum increases
 very much by $y: \frac{1}{2}$ Application of Heat, so
 water ^{ch} in $y: \frac{1}{2}$ ordinary State of the
 Atmosphere dissolves only $\frac{1}{6}$ of Nitre will
 when boiling dissolve a Quantity exceeding
 greater. The Heat may also act as a
 Repellent in separating $y: \frac{1}{2}$ parts of $y: \frac{1}{2}$
 Solvent, but of this more hereafter.
 With regard to $y: \frac{1}{2}$ Application of Heat
 it may be done two ways, either in
 close or open Vessels. in $y: \frac{1}{2}$ latter Practice
 for Solution the Application of Heat is
 much limited, for all Fluids in a certain

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Degree of Heat arrived at w: is called the
Boiling point, after w: they cannot
possibly be rendered hotter: but if more heat
be applied they fly off in vapour; Thus
Red Spirits boil at 176° of Fahrenheit's
-mometer. water at 212° : but Br

Undergo some Resolution by boiling
requires a much greater Heat. The
boiling point of Fluids varies w: the
pressure of the Atmosphere. Baron

Montaigne who lived near the
Pyrenees tried y: Experiment at various
Heights on those Mountains.
found y: as he ascended to diff: Heights
when y: pressure of y: Atmosphere was

consequently less, & that necessary to boil
 water became much less than 212° , & e
 contra $y: y$: boiling point increased as
 he descended till at y : Bottom it arrived
 again at 212° .—

About 80 years ago was contrived an
 Instrument called Papin's Digestor, w:
 is a strong cylindrical Copper vessel, w:
 a Cover fitted so accurately w: a screw and
 lever as entirely to exclude y : external
 air. The Spring of y : Air in this vessel
 being increased by heat may be made to
 act w: a pressure extremely great, w: will
 consequently enable y : contained Fluid
 to bear a much greater degree of heat,
 than it would have done in y : open air;

The Spring of $\frac{1}{2}$ Air may be so enclosed
 as to ~~make~~ break $\frac{1}{2}$. Strongest before
 - to prevent w: there is generally a ^{ch} $\frac{1}{2}$ at $\frac{1}{2}$ Top covered w: a Valve. This valve
 must be compressed by such a weight
 as will give way to $\frac{1}{2}$ Force of $\frac{1}{2}$ Elastic
 Air, before the vessel is burst. Papin's Digester
 are usually made of Copper, or some
 other Metallic Body, but these are
 inconvenient as they are apt to be
 - roded by most saline Substances. The
 Inconvenience has been lately occasioned
 Invention of the Glass Digester. The ^{ch} $\frac{1}{2}$
 w: this bears is not so great as in Paper
 yet it is sufficient for most purposes.

Boiling point of water is perhaps $\frac{1}{2}$ °
 greater th Heat to w: we can expose it w:
 safety; but even this enables us to
 give Ascend. Spirits w: in Open Vessels
 waporates at 176°: the Heat of boiling
 water th w: as we mentioned before is 212°.
 a Thermometer might be inserted into
 this Digester for regulating $\frac{1}{2}$ ° Degree of
 Heat. it is supposed $\frac{1}{2}$ ° Solutions
 made in the Digester differ from those
 made in Open Air, as $\frac{1}{2}$ ° former have
 generally a turbid Appearance; I
 am sure it diminishes $\frac{1}{2}$ ° Degree of
 the preparation; whether it improves
 its active Qualities I shall not here determine.

^{1st} By the Application of Air. Ancient
 Philosophers have supposed $\frac{1}{2}$ water was
 the primum Liquidum, or $\frac{1}{2}$ primary
 Cause of the Liquidity of all Bodies. In
 Speculations & Experiments have made
 rendered it extremely probable $\frac{1}{2}$ Air is
 a principal Agent in giving Bodies
 Liquidity. If water saturated w: Nitro
 be put under a Receiver when the
 Air is exhausted a portion of $\frac{1}{2}$ Nitro
 will be precipitated. When Acids act
 upon Alkalies or Metallic Substances
 a great Quantity of fixt Air is evolved.

it is highly necessary to $\frac{2}{4}$ solution, that
 this Air be absorbed by the external Air, w:
 readily takes place by an Electric Attraction
 between $\frac{2}{4}$ part, and $\frac{2}{4}$ common
 Air, and between $\frac{2}{4}$ solvent and Mer-
 cury. in consequence of this the
 progress of the solution will be much
 impeded by excluding $\frac{2}{4}$ common
 Atmosphere. 29. Copper put into vol.
 Alkali if kept from the external Air
 will not be much affected by it, but if
 free access of the common Air be allow-
 ed the Alkali will quickly dissolve it.
 If after the solution is complete it
 be enclosed in a trial from w: $\frac{2}{4}$ Air is

entirely excluded the Copper in ^{proportion} ^{to} ^{the} ^{volume} ^{of} ^{the} ^{liquid} ⁱⁿ ^{the} ^{time} ^{will} ^{be} ^{precipitated} ^{from} ^{the} ^{liquid} ^{by} ^{the} ^{action} ^{of} ^{the} ^{alkali}. Besides these, very numerous Facts might be adduced to show how extremely necessary the Air is to the progress of Solution. One other I shall mention ^{as} occurs in our History it is when any Corrosive Body is kept in Copper vessels for a long time & part of the vessel only is acted upon. This is Communication between the Air - the Fluid contained - & the vessel with round the edges of the Fluid.

In the Conduct of Solution it is proper to avoid Effervescence & Dissipation

have already shewed that some Bodies
are extremely volatile, so as to be dissipa-
ted wth a very small Degree of Heat. To
avoid this, it is necessary to use close
vessels, and apply very little Heat.

Efferescence is that intestine Moti-
on w^{ch} arises upon the mixture of some
Bodies, from a sudden Extrication of
their fixed Air, and the Reduction of it
to an elastic State. That Efferescence
depends upon a Separation of Air, is
evident from this Experiment. Tie a Blad-
der loosely over the Neck of a Vial contain-
ing Iron Filings; then add a Quantity
of the vitriolic Acid thro' an Aperture in

The side of the trial, and we shall observe
 (if the Aperture be closed) 1st The Bladder
 will be distended with Air as the Efferve-
 scence goes on, till it burst if a vent is
 given. — now this Effervescence is to
 be either avoided or moderated upon
 several Accounts, 1st It is in some Cases
 so violent as to rush over the vessels if
 open, and burst them if closed. 2nd The
 vapours arising from many Bodies
 are so delirious as oftentimes to
 bring on instant Death to Animals who
 breathe them. 3rd These vapours are
 sometimes very inflammable, so that if they
 come in Contact wth burning Bodies

immediately take Flame, and explode ¹² w:
 great danger to the Operator, if they are
 very copious. we may see an Example
 of these inflammable vapours by apply-
 ing a Flame to the vapour of bitriolic
 Acid, and Filings of Iron during their Ef-
 ferverescence.

I shall now go on to mention the
 best Means of avoiding Efferverescence.
 1. By adding the Solvent in small Quan-
 tities, for the Degree of Efferverescence is
 generally proportional to $\frac{1}{2}$ Quantity of
 the Bodies added. we must however ob-
 serve to let $\frac{1}{2}$ Efferverescence of $\frac{1}{2}$ first
 Quantity cease before we add a second.

an Exception to this general Rule.
 -curr in the mixture of vitriol & Acid
 Mercury in w: Case the solvent is ad
 To be added at Once. This is readily
 -counted for, because Mercury when ap
 -plied to an Acid in the cold does not
 afford much Effervescence, but as y
 Heat in which the mixture is made
 increases, the violence also of the Eff
 -vescence will increase in a great pro
 -portion; now if the Mercury be applied
 gradually, in the common way the Heat
 excited by the first Addition, would increase
 the Effervescence of the second, & this of y
 third. yet in the Case of Mercury we

might add it gradatim. provided the
 heat excited by the first, subsided before a
 second Addition was made. This practice
 however would be very tedious.

Another Method is by performing ^{the} Opera-
 tion in close vessels excluding the external
 air, ^{as} it promotes the Solution of Bo-
 dies will consequently increase their Ef-
 ferverescence; but this Operation is attended
 with great Hazard of bursting the vessels.
 in this practice the circulatory Appa-
 ratus which gives Room for the Effluent of
 vapours, or a Matras with ^{the} loose Stopper
 are ^{the} best and most convenient vessels.
 - M^r Geoffroy however has invented a

Method of avoiding the Effervescence
 these by interposing a Quantity of Oil
 between the external Air and ^{the} Menstruum
 — Thus you see a Quantity of Oil floats
 upon the Nitrous Acid, if again we take
 Bits of Iron previously dipped in Alcohol
 that ^{the} Oil may not adhere to them, and
 drop them into the Acid an Effervescence
 will ensue, but not near so violent
 if they had been mixed without the Inter-
 position of the Oil is in the Open Air
 in some Solutions also the Effervescence
 is different as we add ^{the} Menstruum to
 the Solvent, or the Solvent to ^{the} Menstruum
 thus in a Solution of Alcohol in

in a spiritous liquid, the Effervescence is much greater when we add ² Alcohol to the Acid, than when we add the Acid to the Alcohol. This Phenomenon is explained by the Action of the Air; for in the latter case the Acid being heavier than the Alcohol sinks to the Bottom, whereas in the former the Alcohol swims at the Top, and is more exposed to the Air.

We must be careful to distinguish between the intestine Motion named Effervescence, and ² of Bullition and Fermentation.

Bullition is properly applied to that Motion Only which is excited in Liquids

After they arrive at ^{the} boiling point.
 That motion only is called Fermentation
 which has an assimilating power, i.e. when
 the properties of one of the Bodies that
 is added is rendered the same as the
 other. we have an Instance of this
 in Leaven; a small Quantity of which
 added to a larger Quantity of Dough
 leavens the whole, or assimilates it to
 its own nature. —

Solution according to certain
 Differences in the practice is named Macu-
-ration, Infusion, Decoction, Digestion,
Circulation, Deliquescence or Amalgama-
-tion. Macuration & Infusion

This Case it is most properly called Digestion.

5. Circulation is when the vapour arising from one vessel are condensed by another & by some communication return to it first in a liquid form.

6. Deliquescence. The Air is always replete with watery exhalations, w^{ch} some

Bodies are much disposed to attract & run into a fluid state. When

this process takes place it is called Deliquescence. The process of making Br

Myrrh: & Deliquium comes properly under this Head. —

7. Amalgamation. This Term is applied

only to the solution of Metals in Mercury.

Having now considered ^{the} means of
combining Solvents w: their Menstruums,

let us now take notice of the means by w:
dissolved Bodies may be separated from their

Menstruums. This is done by Precipita-
tion - Crystallization & Evaporation.

Precipitation depends upon elective
Attraction so ^{that} it is a species of solution.

When two Bodies united by elective
Attraction a third be added w: unites w:

one, & consequently separates the other, ^{the}
Process is called Precipitation, & ^{the} Body added

called the Precipitant.

There are only four different ways of
Precipitation. —

- 1.st Of the dissolved body alone
- 2.nd Of the dissolved body and $\frac{1}{2}$ Precipitant
- 3.rd Of the Menstruum alone.
- 4.th Of the Menstruum w: $\frac{1}{2}$ Precipitant

Example of the 1st Case. — If to a solution
of Silver in Nitrous Acid be added Filings
or Plates of Copper, the Silver will be pre-
cipitated to $\frac{1}{2}$ Bottom in $\frac{1}{2}$ Form of
White powder, as fast as $\frac{1}{2}$ Copper dissolves
because the Acid has a stronger Affinity
Attraction to $\frac{1}{2}$ Copper than to $\frac{1}{2}$ Silver.

Examp: Case 2.nd If to a solution of Silver
as before we add $\frac{1}{2}$ Muriatic Acid it will
attract $\frac{1}{2}$ Silver from the Nitrous, and

uniting w: it fall to the Bottom in
 a solid Form, for the muriatic Acid
 does not dissolve Silver, ^{but} only corrodes it.
 Example of Case 3.^d If to a Solution of Gold
 in Aqua Regia we add $\frac{1}{2}$ of vitriolic ~~the~~
 the Gold will be attracted by, & suspended
 by the Ether while its former Menstru-
 um falls to the Bottom.

Example of Case 4.th If to a Solution of
 Camphor in Alcohol we add common
 water, the Alcohol and water will unite
 and fall to the Bottom, while $\frac{1}{2}$ Camphor
 will swim on this Surface.

By the third Experim^t: we may

determine the purity of Gold w: ^{the} greater
 -racy, for if any Copper be mixed w: it ^{the}
 Aqua Regia will keep the Copper
 -solved, and by that means appear
 more or less of a blue Colour according
 to y^e Quantity of Alloy.

In the two first of the foregoing Cases
 the falling Body is called y^e Precipitate
 the Magistry or Calx.

There may be Instances w: ^{ch} cannot
 strictly propriety be referred to any of
 former Cases. 2:9: When Silver is added
 to a Solution of Gold in Aqua Regia, it
 attracts, and unites with the muriatic

acid of the Aqua Regia, in consequence
 of ^{ex} the Gold, and ^e remaining part
 of the Aqua Regia viz: the pitious acid,
 will continue separate and unchanged.

If water be added to a solution of Me:
 tallis Substances in Acids, a Precipitⁿ
 of the M: S: ensues. Whether ^e Acid
 has a stronger Attraction to ^e water
 than to ^e M: S: or whether ^e Qualities
 of the Acid w: Relation to ^e M: S: be
 changed by Dilution, I shall not here
 take upon me to determine.

Before we leave this Subject of
 Precipitation, I shall add some
 general Directions for ^e Practice of it.

When Precipitants are used it is necessary
 in general to dilute the solution w: water
 & when Precipitations are effected by water
 alone it must be added in large Pro-
 portions. by this Dilution we can avoid
 perfect Separation. There are some Excep-
 tions to this Rule perhaps that are
 not taken notice of by Chemists. If
 any substance precipitates in particles
 of great minuteness, these may be rendered
 mechanically diffused for a long time, in
 a large Quantity of solution, & Separation
 may be rendered more tedious, if not
 impracticable. in Precipitation
 Effervescence is to be avoided for the same

Reasons, and by $\frac{2}{y}$ same means we
 mentioned when treating upon y Subject.
 We must not add a greater Quant:
 of the Precipitant than is just suf:
 ficient for our Purpose, for many Sub:
 stances if added in a greater Quantity
 than is requisite for y Precipitation of y .
 Silver will occasion y Menstruum to
 redissolve the Precipitant. I. g. If too solu:
 tion of Silver in Nitrous Acid ~~is~~ diluted, be
 added the volatile Alkali gradatim to
 avoid Effervescence a Precipitation will
 ensue. We must continue to add
 gradatim so long as any Milkiness

appears. but if after this the Addition
continued to a certain Degree, & precipi-
tated powder will be again taken up
and the whole become one transpa-
rent Fluid. —

Dulcoration. when a Precipitant has
a part of the Acid which had formerly
dissolved it, still adhering to it, & washing
of that w: water is called Dulcoration.

Corrosion. when a Metallic Substance
can be combined w: an Acid in a dry
Form only the Combination is called
Corrosion.

In most of the Practices of Collection
there is Occasion for Colation & Filtration
— the first of these Terms is applied to

straining thro' coarser Filters, as the
 Hair: Live - woollen Cloaths &c. Mulat:
 is chiefly used for y^e finer Filters as
 Paper &c. the most convenient kind
 for this purpose is Blotting paper, the
 Filters of which are longer than of common
 Paper. —

In Opposition to Solution is Coagu-
 lation, or the Practice of reducing
 Fluids to a solid Form. —

The Action of Fire has y^e Effect of co-
 agulating Animal Fluids, as we see
 in the Whites of Eggs, and many other
 Cases.

Sometimes dry Bodies ~~undergo~~ coagu-
 late

Fluids by entangling them in thin films
 and preventing them from moving
 freely. E.g. If to an English pint of
 common water, be added a teasp-
 -full of Salop (w^{ch} is a Root brought
 in from the Levant) in fine powder, the
 whole will shortly become a thick Jelly.
 Most Instances of Coagulation are owing
 to the Effect of Precipitation, so appears
 from adding Alcohol to a Solution
 of Glauber's Salt in water. ^{But} ~~even~~ in
 this case it only happens in consequence
 of Agitation, for if the Alcohol be ad-
 -ded gradually, & or the solution suff-

to remain at rest for some time, even
 after it has assumed a solid Form, the
 Alcohol will attract the water to the top,
 and the salt will be precipitated to the
 Bottom. —

Of Fusion. —

Before I speak particularly of Fusion,
 or the Reduction of solid Bodies to a flu-
 id Form by the Action of Fire, I shall
 say something concerning ^{the} Theory
 of Fluidity in general. —

The Ancient Philosophers viewing ^{all}
 all Fluids as Bils. Luids, and ^{all} Spirits
 and even Mercury received water into
 their Composition, concluded that

Water was γ : ¹primum Liquidum or
 universal principle of Liquidity. This
 Reasoning however is easily overthrown
 by considering that water is not the cause
 of its Liquidity, and γ : many solid Bodies
 mixed w: water increase its power of
 retaining Liquidity.

The Corpuscularians say γ : the Li-
 quidity of water depends upon γ : ²Spherical
 Figure of its Particles, w: ^{ch} slide easily
 over each other, and yield to the least
 pressure. This Opinion is false & im-
 probable, for these Spherical Atoms
 were never proved to exist, & even grant-
 ing the Existence of such Particles, it is

on to me altogether invariable how by
 this the Diminution of One or two Degrees
 of Heat in the Thermometer, these
 Particles can be so entirely deprived of
 their Figure as to form a mass, hard
 and solid, or how by restoring ~~this~~
 the Heat they can regain their special
 Figure and instantly become fluid.

we know no Body in nature that
 will not assume a fluid Form under
 a certain Degree of Heat, nor is there
 any Body in nature which will not
 under a certain Degree of Cold assume
 a solid Form, however After we meet
 with it in a fluid state. Hence it

appears y: ² Fluidity is not essential to
 any Body in particular. I shall
 therefore when I mention Fluidity
 understand by it a certain Relation
 of Bodies to Fire. — which seems to be
 the sole Cause of Fluidity. ^{Fluidity} Solidity and
 Vapour in Bodies of Bodies seem all
 to depend upon the State of Elasticity
 upon their Surface, & within their Pores.
 When the Repulsion of y: external ^{Other} ~~the~~
 prevails over that of the internal, the
 Body is preserved in a State of Solidity
 when by the Action of Fire the Elasticity
 of the internal Other is much increased

no exactly to counterbalance ^e external
 the Body is reduced to a state of Fusion.
 but if the Fire be still further encrea-
 sed, the internal Matter acquires a still
 stronger repulsive power, and becomes
 superior to the external, then ^e Body
 flies on in vapour, each particle being
 as it were surrounded, by a repellent
 power of its own.

Fusion combines Bodies by ^h which
 has been called dry solution, & separates by
 selective attraction or the action of fire
 in different degrees on different Bodies.
 When an selective attraction takes
 place under Fusion the Operation is

named a Precipitation by Fusion, or
Precipitatio fusoria, and in the Case
 of Metallic Substances the parts sep-
 arated are termed Scoria or Regulus. The
 word Scoria was formerly applied to the
 gross part only w^{ch} is thrown out in the
 Precipitation of Antimony, but it is
 used to signify all y^e vitrified friable
 matter that is thrown off by Metallic
 Bodies in a great Degree of Heat.

The pure Metallic part of Antimony
 concretes somewhat in y^e Form of
 a Crown, & hence it received y^e Name
 of Regulus or little King. This Term

however is now applied to $\frac{2}{y}$ Metals.
part of all Substances. —

As an example of this kind of separation
viz: by Elective Attraction, let us see:

in the Process of purifying crude
Antimony. This Substance is composed

of Sulphur and a pure Metalline

part called Regulus. it is required to

separate the Sulphur from the Regulus.

to effect this we must find a substance

which has a stronger Elective Attraction

to Sulphur than the Reg: of Antimony.

among such substances we shall

find Iron or Tin. let us therefore put:

thin plates of Iron into a Crucible in

Melting Furnace w: the addition of
 little bit alkali to promote ^{the} fusion
 When the Crucible is red hot, put in
 Antimony. Let the whole be fused to-
 gether. After this removing ^{the} Crucible
^{from} fire, suffering it to cool, we shall find
 the Regulus at the Bottom, and the
 Sulphur united w: the Iron in Scoria
 at the Top.

As an Example of the second kind of
 Separation viz: by the action of Fire,
 we apply a mixed mass of Lead & Copper
 to a heat just sufficient to melt the Lead
 in consequence of this the Lead will all be
 fused, & run out while the Copper will

remain unchanged.

The Fusion of Bodies may be consi-
dered as of two kinds; the one when y^e
Body melted suffers no Change, but y^e
by the Action of Fire, from solid it
becomes fluid, and upon removing y^e
Fire concretes into y^e same Form as
before. The other Case is, when y^e Body
melted suffers such a Change, that upon
cooling it does not concrete into the
same Form as before. of this y^e most
noted Instance is Vitification.

The Fire separates Bodies under two
on by acting upon y^e common Fusi-
bility or by acting upon y^e Vitescency.

upon the first depends Liquefaction and
Congelation, upon the second depend
 Scorification and Cupellation.

When solid Bodies varying in their
 Fusibility are combined, & we separate
 them by that means, as in the last Ex-
 -ample of Lead and Copper, & ^{the} Operation
 is named Liquefaction.

The Separation of fluid Bodies by
 carrying the Heat below & freezing them
 or in other words by increasing & Cold
 called Congelation, and is just the
 Reverse of the former, tho' both depend
 upon the same Principle. Viz: & different
 Degrees of Heat, and the different Fusibilities

of Bodies. 2.9. If a Degree of Heat below
 30: in Farenh: be applied to a mixture
 of Alcohol and water, the water will soon
 be converted into Ice, while $\frac{1}{2}$ Alcohol
 on acc: of its greater Fusibility will
 remain fluid ~~and pure~~ and pure.

If Lead be continued on $\frac{2}{3}$ Fire
 After Fusion, a thin pellicle will ap:
 pear w: will break and retire to $\frac{2}{3}$
 Edge; this will be succeeded by a second
 &c - till the whole Mass be converted
 into thin Pellicles or Scoria. This Op-
 eration is called Scorification, & is
 much expedited by a continual Blast
 of Air upon the Metal.

If these Scoria be exposed to a greater
 Degree of Heat, they turn of a dusky brown
 Colour, and after γ they become Red
 -Lead or minium. if the minium is fu-
 -sed it will concreate into vitrified
 Mass. This latter Process is called Cal-
 -pellation. The minium when in
 Fusion is of so subtle a nature, that
 it pervades γ Pores of almost any
 Vessel, hence it has been a Residue
 -turn Among Chemists to invent
 Substances γ would contain it.

Lead is not only of itself readily
 vitrified, but it also disposes various

Other Bodies to Vitriol, as Salts,
and all Metallic Bodies except Gold &
Silver. Hence if these be fused w. ^{the} Lead it
separates in the form of Scoria, accom-
panied w. ^{the} all the heterogeneous matter
of the Gold and Silver. —

When a Metallic Substance has
been deprived of its Metallic Form, &
is by certain means under Fusion
brought back to it again ^{the} Operation
is named Reduction. — This is effected
by letting the changed Substance come
in Contact w. ^{the} Vegetabile Lead in
Cases of Vitriification. I.e. if the
Minimum of Lead be fused w. a Quan-
tity

of Charcoal, it will recover its former Metalline Appearance. —

The vessels most commonly employed in Furnaces are Crucibles. Those which were made formerly in Hesse of a particular kind of Earth, and were named German Crucibles. but they are greatly inferior in strength & Dexterity to those made now in Britain of Black-Lead. — it is necessary in many Operations to prevent the Contact of burning Fuel. this is conveniently done by stopping the

^{the} Crucible w: a smaller inverted.

In Scorification we are employed Pots
Cupels, and Muffles. The Pot or Cupel.

^{ch} is smaller, and more used at present.

is put into a muffle to prevent ² Contad

of the Fire w: is a necessary Caution

in these Operations. —

Of Exhalation.

When the parts of Bodies are separated.

^{ch} w: at present cohere, and fly off in the

Air, such Bodies are then said to be vola-

tilized, or exhaled, and ² Operation is

named Exhalation. —

The principal Causes of this are as

follow; either when the parts being
 specifically lighter than air are buoyed
 up therein, or 2.nd the air acts upon
 Bodies as a menstruum, & by that
 means carries them off. or 3.rd when
 the parts are driven off by the force
 of Fire. The distinction between the
 first and last is extremely nice; for
 the Fire acts as well by rarifying Bo-
 -dies as by rendering them more
 Elastic.

Exhalation is various, as it is pro-
 -duced for obtaining the - fixed parts

- Fixed parts

{ of Fluids by evaporation
 { of Solids by Ustulation & Calcination
 The volatile Parts

{ in a fluid Form by Distillation
 { in a solid Form by Sublimation.

of a like nature wth these two last, but become
 what different in the Manner of Operating
 are Cementation and Infusation.

When in separating the volatile parts
 of Bodies we apply them at the same time
 to other purposes, the Operation is called
Cementation. from a Resemblance it
 is thought to have to the work of Masons.
 e.g. If I have a Compound of Gold & Silver
 I can by the same Operation Obtain a

Solution of the Silver and a Separation of the
 it from the Gold; lay a Stratum of green
 vitriol and Nitre upon the Bottom of your
 Vessel, and over this a plate of $\frac{1}{2}$ mixed Metals.
 Let this be repeated till the vessel is full.
 Then lute it, and apply it to $\frac{1}{2}$ Fire. in
 this Operation the Acid of the vitriol unites
th w: the Alkali of the Nitre; - the Acid of the
 Nitre ascending in Fumes unites with
 every portion of the Silver of the mixed
 Mass in the form of Corrosion, w: may there-
 fore be swept quite clean from the Gold.

When Nitre is applied to burning Metals
 its Acid is exhaled, and $\frac{1}{2}$ Alkali remains
 behind. This is an Instance of Inflammation
 or the Application of Bodies immediately to

tion of the Fire. Under this is comprehended ² what
 has been called the Sublimation of Geber.

I now proceed to consider ² Operations
 belonging more particularly to Exhalation.

Evaporation is practised on Fluids chiefly
 for obtaining the fixt parts, while the
 volatile are suffered to fly off, & according to
 certain Circumstances of the Subject is
 named Inspiration or Extraction. —

When a Fluid contains a number
 of heterogeneous Bodies more fixt than
 itself, if we evaporate this considerably, ²
 heterogeneous parts will render ² remain:
 the Fluid thicker, whence ² Operation
 has been named Inspiration. —

When we practise on Animal & Vegetal
 Substances in Order to Obtain their Virtues
 by Solution we must use a large Quan-
 - tity of the Menstruum. This however
 often renders the Preparation too bulky,
 so y^e we must reduce it by Evaporation,
 and this Operation has Obtained y^e Name
 of Extraction. —

When Bodies suspended in a Fluid by
 Solution are made to subside, they com-
 - monly assume the Form of Crystals;
 hence the Term Crystallization. This is
 almost universally applicable to solid
 Bodies only; I do not say wholly, be-
 - cause, so far as we know it may be

practised upon some other Bodies. here indeed promotes it in all Bodies.

Crystallization depends sometimes upon diminishing the Heat. for if boiling water, saturated with nitre, be set to cool, we may observe the nitre crystallizing as the Heat decreases. but as it more generally depends upon diminishing ^{the} quantity of the Menstruum by vaporatⁿ it belongs properly to this Head.

3 Vaporation is carried on by ^{the} action of Air or Fire, or by the joint action of both. The Air serves not only to buoy up the parts separated by Fire, but acts also upon many Bodies as a Menstruum, and ^{is} like other

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Menstruums in proportion to its Heat as
I shall endeavour to prove hereafter.

It may be useful now to add some
Rules for the practice of Evaporation.
Evaporation we are liable to many Incon-
-veniences from an Excess of Heat, for the
parts of some Bodies differ so little in their
Fixity, that without great Exactness the
Whole will be dissipated; or when ^{Exhalation}
is performed too rapidly, the light fixed
parts may be carried off by the volatile,
or they may be entirely changed and
contract an Impireuma, to which all
Animal and Vegetabile Substances are

Proxious from too great Heat. to the
 viate those Inconveniences & to lessen y.^e

Labour of the Operation, some Medium

is interposed between the Subject & the

Fire, w.^{ch} will bear a slow regular, and

determined Heat Only, for this purpose

Fluids w.^{ch} receive no Heat after the Boi:

ling point are most proper. in different

Cases we ought to employ Fluids of

different Fixities; for some Substances

undergo a considerable Change of Qualities,

even from the Heat of boiling water.

The water should be continually stirred

till it boils, and then y.^e Bullient

Motion will answer the purpose, ~~the~~
 the more solid parts lying in Contact with
 the Bottom of the vessel, may become ~~in~~
pyreumatic.

The Surface of the Fluid ought to be as
 much increased as possible, for vapora-
 tion is found to go under a given Degree
 of Heat in proportion to $\frac{1}{4}$ Quantity of
 Liquor exposed to the Air. —

The late ingenious Dr. Hall invented
 a Method of throwing fresh Air continually
 upon the evaporating Liquor, thereby very
 much facilitating the Operation.

Ustulation. When a Body exposed
 to the Action of Fire, After a Disipation

of its volatile parts, retains its Original Texture, and some Degree of Firmness, it is said to undergo *Ustula*:
tion. But if under this process ^{the} Body
loses its Texture, and falls into a powdery
State, the Operation is called Calination.

The Calination of many Bodies wi:
dently depends upon a Disipation of
their volatile parts, but the Calination
of Metals, and other Bodies w: acquire
an additional weight cannot be expl:
by any Hypothesis yet advanced.

In the practice of Calination we
must observe whether our Subject

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calines but in a solid or fluid Form
Lead is most readily in the latter. Iron
Copper &c in the former State. -

Distillation

This is distinguished according to the
Subject, into simple Distillation (sim.)
= properly called the Chemical Analysis
and Distillation w. ^{the} addition.

I have little to say on ^{the} Subject of
simple Distillation, having treated
Evaporation so fully. it depends chiefly
on the Action of Fire; for $\frac{1}{4}$ of small
Quantity of Air. contained in $\frac{1}{4}$ of distilling
Vessel is so diminished by rarefaction,
as to produce no sensible Effect in the
Operation. hence the Reason why an

Increase of Heat is necessary towards
the End of the Process, when γ : contained
Air is almost entirely driven out.

Distillation th is Addition is a more
complex, and a more useful practice
than the former. The Addition is made
for several purposes. 1st by Electric Attraction
for letting loose a volatile part.
Thus in distilling the Acid from Nitre,
we add the vitriolic, this having a
stronger Attraction to the Alkali of γ :
Nitre than its own Acid, separates the
latter, in wth State it is easily Obtained
Alone. — 2^{ndly} by Electric Attraction
for fixing One of two volatile parts.
— Thus Sal Ammoniac is a Mist com-
posed

of Muriatic Acid, and Volatile Alkali, by
 adding therefore $\frac{1}{2}$ of vitriolic Acid, we
 fix the Alkali, and are thereby ena-
 -bled to separate $\frac{1}{2}$ Muriatic Acid by
 Distillation, or again by adding a
 fixt Alkali we fix the Acid, & separate
 the Alkali. 3rd by Selective Attraction
 For separating a fixt part, by uniting
 this, for volatilizing it. Thus crude
 Antimony is composed of Sulphur &
 a Metalline part. by $\frac{1}{2}$ Addition of
 Muriatic Acid, the Metalline part u-
 -nites ^{2nd} w: it, & becoming Volatilized
^{2nd} w: it in Distillation in $\frac{1}{2}$ Form of
 Matter of Antimony. at $\frac{1}{2}$ same time

we add Mercury to fix the Sulphur, or
 we may add the Muriatic Acid & $\frac{1}{2}$ Mercury
 united in $\frac{1}{2}$ Form of Corrosive Sublimate.

4th By uniting w: the whole a mist for
 volatilizing it. Thus by adding Copper
 from to Sal ammoniac we increase
 the volatility of both Ingredients.

5th By dividing an Aggregate for preven-
 ting its Fusion, and thereby favouring
 its Resolution. Thus if Brick-Dust or
~~powdered~~ ^{dried} Clay be mixed w: powdered
 Nitre its Fusion is in some measure
 prevented, and its Resolution considera-
 bly retarded. The ancient Chemists
 knew the Advantage of this Practice,
 tho they were ignorant of $\frac{1}{2}$ Cause.

6.th By dividing an Aggregate for
 preventing Intumescence, & thereby
 favouring the Separation of the parts
 involved. Air is an Ingredient in all
 Bodies, and being set at Liberty by
 Distillation, rises in Bubbles: if the
 Liquid be viscid, collect in such Quanti-
 ties as to endanger the vessels, or run
 over into the Receiver. This happens in
 the Distillation of Amber, and various
 other matters. hence the necessity of adding
 Sand w.^{ch} being in part necessarily car-
 ried up by the Froth contributes by
 its weight to break the Bubbles before
 they arise to a considerable Height in
 the vessel.

7. For regulating the Degree of Heat & C.
 In the Distillation of Essential Oils we
 add water, w^{ch} can only acquire a deter-
 minate Quantity of Heat, for preventing
 Empyreuma. —

Before we proceed to the general Rules for
 the practice of Distillation it may not be
 improper to explain a few Terms.

When a Matter Obtained by One Dis-
 tillation is subjected to a second, that it
 may be more entirely separated from
 Matter that adhered to it in the first,
 such second Distillation is named Recti-
fication, Dephlegmation or Concentration.

Ardent Spirits after a second Distillati-
 on leave a considerable Quantity of water

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^{ch}
w: they hold at first, and therefore be-
- come more pure, hence they are said
th
w: some propriety to have undergone
a Rectification.

Dephlegmation takes its Rise from
Phlegm ^{or} w: is the name Chemists have
given to water. This Term is properly
applied when we evaporate water
from any Body ⁱⁿ w: contained it.

When the parts of a Body separated
diffused in any medium are bro't to-
- gether together, the Operation is called Con-
centration. but this Term how-
- ever nor the foregoing are confined
altogether to the Operations of Distillation

In Case 3rd and 4th when a Matter Ob-
 tained by one Distillation is returned up-
 on ^e same matter from w^{ch} it was drawn
 before, to be again distilled from it for Obtain-
 ing a stronger Impregnation. such a
 second Distillation is called a Cohobation. This
 is of two kinds. The first is when the
 Matter is returned on the Subject from w^{ch}
 it is drawn. The second is when ^e matter
 distilled, not upon the Matter from whence
 it was drawn, but upon a fresh porti-
 on of the same kind.

Distillation according to ^e Form of
 the vessels employed, is distinguished into
 1. That for ascensum in w^{ch} ^e Cucurbit

and Alembic are employed.

2^{ndly} That per Obliquum in w: ^{ch 2} Retort
is employed.

3^{rdly} That per Descensum in w: ^{or} the
vapours are driven into a vessel placed
below the matter from which they are
drawn, by means of Fire applied upon
an Iron Plate, to the mouth of the
containing vessel. This Practice how-
ever is now generally deserted.

In the Practice of Distillation we
must have Regard to the Form and
Matter of the Vessels we use.

As to the Matter Glass is certainly

best; as it is capable of containing the
 most subtle Bodies, of resisting ^{& Force}
 of any Menstruum, and has also ^{& Adv.}
 vantage of Transparency. its ready Pen-
 sibility however is a Disadvantage.

White Flint Glass is the most fusible of all
 Others, yet it is to be preferred where ^{& Degree}
 of Heat will not act upon it. When a greater
 Heat is required than Flint Glass will
 bear we may use German Flint Glass;
 and if we require a greater Heat than this
 will bear, we may be greatly assisted by
 giving it a Coat of Wind or Loam. if
 we are obliged to employ a greater Heat
 than any of these (w^h is seldom ^{& Case}
 we must use Darken Retorts.

As to the Form of the Vessels we shall understand them better by seeing the Figures than by verbal Description.

The vessels should be as thin as is consistent wth safety, and of the most uniform

Thickness possible. — When Bodies whose parts are nearly of an equal volatility are to be separated, it is common to

employ an Alembic and Cucurbit of such a Height as y^e the more volatile parts only may be able to ascend: but I find

greater Advantage in this particular from a proper Regulation of the Heat from y^e Height of the vessels. The Cucurbit and Alembic are also inconvenient

as there are two Functures to be closed. so
 y: the Retort and y: Receiver w: have but
 one Functure, and y: more easily closed, are
 now very generally employed. The only Ad-
 vantage of the former is that from y: wide-
 ness of its mouth, we may get matters out
 for which we sh^d be obliged to break a
 Retort. —

with regard to the filling of y: vessels
 if the Bodies are fluid it must be done
 by means of a crooked glass funnel,
 Care being taken not to let any of the
 Matter drop upon the neck of y: Retort.

In putting in solid Bodies if any portion
 sticks to the neck, we must wipe it

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carefully away. The vessels according to the
Common Rule may be $\frac{2}{3}$ full. This
will do for ordinary matters; but when
Subject is more disposed to Intumescence,
or affords a great Quantity of Elasticity,
-pours, the proportion must accordingly
be diminished. — When $\frac{2}{3}$ Subject is dry
and not apt to swell, we may fill the
Retort up to the neck or near it. —

All the Matter sh^d. be put in at Once if it
can be done, and no Addition made dur-
-ing the Operation. When this is requisite
we ought to use tubulated vessels Retorts,
that is $\frac{2}{3}$ Addition may be made without
destroying the Luting. These are also
necessary where the Fumes arising from

the matter to be distilled under the joint
 of the vessels. —

The vessels sh^d sit each other so exactly
 as to prevent the escape of the rising fumes.
 Their junctures however may be more secure-
 ly closed by the various kinds of lutings
 as Slips made of wet Bladder tied round,
 or a Luting made of Meal and water wth a
 little Whiting, or One of Linseed Oakes and
 water, or wth is still better, One of made
 of Clay, and a Quantity of Sand sufficient
 to prevent the Clay from cracking wth
 the Heat. it is proper to let the lutings
 be quite dry before we apply the vessels to
 the Fire. —

The proper Application of the Fire

comes next to be considered. This should
 be done by very slow and gradual steps.
 Otherwise we most inevitably break
 our vessel, or cause some part of the
 matter to rise w^{ch} will disappoint us
 of the Operation.

The Heat applied must be also regula-
 -ted according to y^e Disposition of the Body
 to expand or contract. Here we may
 employ Sand or Brick Dust for the
 purpose above mentioned.

Many Bodies afford such copious
 elastic vapours, that y^e utmost
 Caution in Applying Heat will not
 prevent the bursting of our Vessels.

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In such Cases several Expedients
have been contrived 1st the Opening
the Lutes. 2nd the Tube to be inserted
into the Receiver w^{ch} was invented by
y^e ingenious MacLevis 3rd the Hole
drilled at y^e side of the Receiver. —

The first Method is inconvenient and
generally attended wth a Loss of our
matter. to the 2nd we may Obj^t that
it is extremely difficult to determine
the size of our Tube: if too large we
lose much of the matter; if too small
it will not conduct our vapour fast
en^o to save our fuel. — the third

Method invented by M^r. Godfrey is the most simple and convenient. The Hole must be stopped wth a wooden peg in such a manner as to be forced out before the vapour is sufficient to burst the vessel. —

Many Substances w^{ch} are distilled concrete before they get to the Receiver and by that means stop up the Neck of the Retort. we must avoid this by employing wide neck'd Retorts & by keeping the Neck hot, that y^e Liquor may continue fluid till they arrive at the Receiver. in distilling Butter

of Antimony we are obliged to apply
burning Coals to the neck of ^{the} Retort:
but in most Cases hot water will be
sufficient.

Distillation may be expedited by throwing
air into the vessels. D. Hall proposed
this as a convenient method of dis-
tilling sea water at a small expense.

D. Hall from the Introduction of Air
thru an accidental Crack in his vessel
found that the vitriolic Acid became
volatile. we may convey Air into our
distilling vessel by using a tubulated
Retort. —

many methods have been proposed

for separating when it is necessary ^e y: several
 matters arising successively in Distillation
 the best of these contrivances is ^e y: Receiver
 - ver th w: a Tube going from its Bottom
 to ^{ch} w: different vials may be applied for
 collecting the several parts as they arise.

If, as soon as the Operation is fini-
 - shed the Vefuls be Opened, the cold Air
 rushing in is sure to break them.

Besides many vapours require some
 time to condense ^{ch} w: by Opening the
 Veful too soon will be lost: or they
 are frequently noxious. -

When several matters are collected
 in One Receiver, they may be separated

According to their Specific Gravities, by
 a Cup constructed w: a proper Spout, or
 by a Separatory Funnel. —

In the last place I must observe ²:
 the Fumes escaping in the course of the
 Operation are to be examined, for
 there being often very inflammable or
 deleterious may occasions conside-
 -rable danger to a heedless Operator.

Sublimation

is conducted by the same principles
 as Distillation. its products are diffi-
 -rent as they are 1st in powder and are
 called Flowers, or 2nd in solid concretions
 and are then called Sublimates.

To this Art. of Chemical Operations it may be useful to add by way of Appendix an Art. of the different Methods of the Application of Fire. —

Appendix.
Of the Application of Fire. —

The Ancient Chemists observing the Heat arising from Fermentation, from burning Bodies or culinary Heat, from the Rays of the Sun supposed that each of these was of a distinct & separate nature; but it seems now to be the general Opinion of Philosophers, that there are only different modifications of the same active Principle of Fire,

The Heat Obtained by collecting the
 Sun's Rays in a burning Glass, is Often
 very necessary as it is most intense: but
 since the Heat Obtained from burning
 Bodies or culinary Fire is most con-
 -veniently and commonly employed
 in Chemical Operations we shall treat
 more fully of its Application. —

In the Application of the Heat com-
 municated by burning Bodies we

consider the

Direction of it, and 4th Regulation of
 its Degree.

The Direction is } 1st the naked or open Fire
 of three kinds } 2nd the Reverbera^{ry} Furnace
 } 3rd the transmitted Heat.

The 1st is employed

- Where a great Degree of Heat is requi-
- red.

Where the Matter to be acted Upon
cannot be committed to Vessels.

Where the Matter is not hurt by the
Contacts of burning Fuel.

Where the Vessels employed are fit to
Sustain the immediate Action of burning
Fuel.

The 2nd or Reverberatory Furnace is
employed.

Where a great Degree of Heat is requi-
- red.

Where the Heat is to be applied to a
great Quantity of Matter or to a great
Number of Vessels at y^e same time.

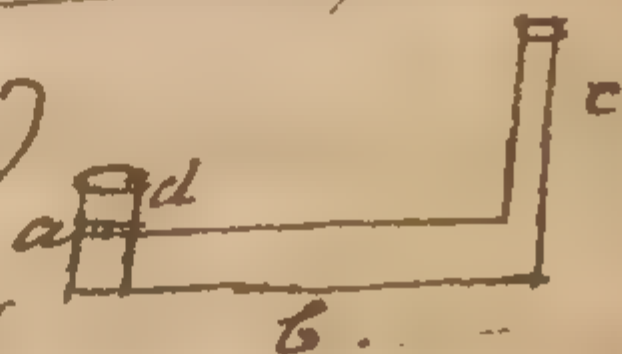
Where the immediate Contact of y. Fire
would disturb the Operation.

Where it is useful to inflame & consume
the Smoak arising from burning Fuel.

This is affected well by the Focus apparatus

represented in the Figure.

a is a Grate fixed at the
Junction of the perpendicular



Short tube d, and the horizontal tube b

When a Fire is made on the Grate a the

Air in the Tubes becoming rarefied is dri-

ven by the external Atmosphere violently

thro' the long tube c by w^{ch} a very entire

Consumption of the Smoak & footenues.

This Furnace is employed partly where

The Direction of the Fire is best suited
for collecting the Matter melted by it.

The 3^d or transmitted Heat is employed
when the Heat is communicated to
the containing vessel thro' Sand, Water
or some other Body interposed. This
is employed.

When a moderate Degree of Heat is requ^d
where a very gradual & exactly con-
- ducted Heat is necessary. for this pur-
- pose Sand is very convenient because
both in receiving and losing Heat it is
extremely equable and gradual. -

When an exactly determined Degree of Heat

is necessary. in this case we generally employ a fluid which bears only a determined Degree of Heat. it would be a very useful Improvement upon ^{the} Digestor to enable us to raise the evaporating Heat of water above the common boiling point at 212, by regular and certain Degrees.

The Heat of metal remains equal from the time it begins to melt till the whole is in Fusion. it has therefore been proposed to determine the Degree of Heat by knowing in a piece of unmelted metal, successively as the first is fused. —

Where the Matter to be operated upon may be hurt by a Communication wth the

Burning Fuel, or the Smoke arising therefrom. —

Where the vessels employed are not fit for sustaining the immediate action of the burning Fuel. —

Of the Regulation of the Degree of Heat

To be able to regulate the degree of heat it is necessary to know ² Circumstances ^{or} which occasion a greater or lesser Degree of Heat. These are 1: the nature of ² Fuel, i.e. the Quantity of Phlogiston in a given time. —

It not only depends upon ² Quantity of Phlogiston, but also upon the Degree of Density of the Aggregate. Thus Straw may have as large a proportion of Phlogiston

as wood, but being of a rarer & lighter
Texture, it burns away sooner, and w:
less ~~weight~~ Heat. —

2^d The Quality of the Fuel being gi:
ven the Increase of Heat depends upon
the Quantity inflamed. —

When the Rays of the Sun are collected
in a burning Glass, they again diverge
from the Focus, and the Intensity
of the Heat decreases in a Ratio with
the Distance from the Focus or Centre,
because there are fewer Rays in a given
Space. now we may consider every
inflamed point upon $\frac{1}{4}$ Surface of a bur:
ning Body as a Centre, or Focus from

which diverging Rays issue. it is cer-
 -tain then that where a greater Quan-
 -tity of Matter is inflamed, there will
 be a greater Number of inflamed points
 and consequently a greater Heat.

3.^d The Quality and Quantity of the
 Fuel being given, the Increase of
 Heat is in proportion to $\frac{1}{4}$ more or
 less entire Inflammation of it. When a
 piece of wood is put into $\frac{1}{4}$ Fire
 it is ^{not} totally inflamed, for a considera-
 -ble part of it flies off in Smoke and
 soot. Now if we can by any means
 inflame these, the Number of radiating
 points will be increased in a given
 Quantity

of matter, and consequently the Intensity of the Heat. to this Cause I attribute the great Increase of Heat by blowing the Flame of a Candle with a Blow-pipe, for a strong Current of Air investing the Flame confines the parts, and by keeping them longer in Contact wth the Flame occasions a more total Consumption.

4th The Degree of Heat is regulated by the slower or quicker Inflammation of the Fuel depending on the velocity of the Air applied.

The Whole of the Consideration we are now upon depends upon this. that the Intensity of Heat is in proportion

to its Density. The Density increases according to the quicker Succession of the Application of Heat, now, since Inflammation cannot go on, unless the rarefied Air next the Surface of the Body be succeeded by the fresh external Air, the quicker Inflammation will certainly increase as the Successions of fresh Air become quicker, & will depend upon the Velocity of the Air applied.

This Velocity of the Air applied is determined by Bellows, a Water Blast Polypile or the Structure of Furnaces.
In the Structure of Furnaces we

must attend principally to $\frac{1}{4}$ Con-
 -struction of the Chimney. From con-
 sidering the Principles upon which
 Air is made to rush up a Chimney,
 it will appear that the velocity of it
 is determined in some measure by
 the Height of the Chimney, because
 the Column of rarefied Air is increased.
 Upon this Supposition, many People
 the Iron Foundries in particular have
 raised their Chimnies to a most erroneous
 Height, but this is certainly unnecessary.
 For Mr. Pott finds, that $\frac{1}{4}$ Draught of
 the Chimney depends more upon the
 Ratio between the Diameter & $\frac{1}{4}$ Height

than upon y : Absolute Height of y Chim:
 :ney. so that w: a Diameter of a certain
 proportion he obtained the greatest
 possible heat from a Chimney only 8
 Feet high. —

5: The more or less exact Confine:
 :ment of the Heat arising from the
 burning Level. —

Any given Quantity of burning
 Level exposed to the external Air
 upon all sides will have much less
 Effect upon a vessel applied than if
 it were enclosed by Brick work, or
 otherwise as in a Furnace &c. it is
 not only of Importance that y burning

Fuel be enclosed by some Body, but also that this Body be of such a Texture or Thickness as not readily to transmit Heat, and in general the Thicker the Wall the greater will be the Heat.

By the Consideration of ² Regulation and Direction of Heat is ~~considered~~ determined the Structure of Furnaces.

The Parts of a Furnace may be the Ash-hole to receive the Ashes that they not block up the Furnace. the Focus or the place where the Fuel is burnt.

the Laboratory or the place where the Matter to be operated upon are placed. the Chimney ^{or} conveys a swift Curr^t of Air thro the Furnace.

The chief Species of Furnaces are

- 1st The Forge.
- 2nd The melting Furnace.
- 3rd The distilling Furnace w. a naked Fire.
- 4th The Assay Furnace.
- 5th The Reverberatory distilling Furnace.
- 6th The Iron Foundries Furnace.
- 7th The Potter's Furnace or Kiln.
- 8th The distilling Sand Furnace.
- 9th The Alkanon.
- 10th The Lamp-Furnace.

End of the Operations of
Chemistry. -

Of the Chemical History of Bodies

The greatest part of Chemical Know-
ledge depends upon the Knowledge of
Chemical Facts. And therefore we shall
endeavour to deliver in a systematic
manner; But System however cannot
be complete since the Science itself is
otherwise. we shall consider the Objects
of Chemistry in the Order which we
observed in the first part of our Course.
beginning wth the saline Bodies as they
have a more general Relation to other
Bodies than any Class whatsoever.
For the simple salts & their Definition

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see the former part of our work under $\frac{2}{3}$
Objects of Chemistry. -

Each of the four kinds may be combined
wth the ~~four~~ three Alkalies into dif-
ferent neutrals, and as only one of
each can be combined at once it is
evident that only 12 neutrals can be
formed by them. - The names and
various combinations of wth I shall set
down in the following Table. The acids
and Alkalies preclude each other according
to their powers of Attraction. it is exten-
sively useful to fix in our memories the
combination of these salts, & method by
which they may be decomposed. The
Vitreous Acid decomposes $\frac{2}{3}$ neutrals

composed by the Other three. $\frac{1}{2}$ Nitrous
 those formed by the Muriatic & vegetable.
 The Muriatic decomposes those formed
 by the vegetable.

Before we enter upon the History of
 the different Salts we shall say some-
 thing of their Solution, & of the means em-
 ployed to recover them from their Men-
 strua. Water is universally a Menstruum
 of Salts, and it is doubtful whether any
 Other Bodies can dissolve Salts but in
 proportion to the ~~quantity~~ water they
 contain. a Cubic Inch of water mixed
 wth a Cubic Inch of vitriolic Acid will
 be considerably less than two Cubic

Inches, whereas some other salts mixed w: water give the same or a greater Bulk than they occupied before. This may afford Subjects of Speculation w: we shall not enter upon at present.

Salts differ in their Degree of Solubility but w: the exact proportion that may be dissolved in a given quantity of water we have not been able to determine, because the Salts themselves are not steady in their Characters. Let it suffice that boiling water dissolves more salt than when it is at y: common Heat of the Atmosphere, and that

fixed vegetable Alkali is most soluble,
 next regenerated Tartar, next Glauber's salt,
 digestive salt, common salt, common
 ammoniac, common nitre, Cubic nitre,
 fossil Alkali, and lastly bitriolated Tartar.
 no accurate experiments have been made
 upon the other neutrals. The Quantity of
 salt soluble in water, is in proportion to
 the Quantity of air present in the water,
 for if a saturated solution of salt & water
 be put under the exhausted Receiver of $\frac{20}{4}$
 air Pump, a portion of the salt will
 immediately precipitate. hence we may
 conclude that water when deprived of
 some of its air by Fire does not dissolve

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as much as might be expected from
the Degree of Heat increased. Another
curious Fact relative to the solution of
Salt is, that when water is saturated
wth one Salt, it will dissolve any other
nearly in the same proportion that
it would before the first Saturation. a
saturated solution of nitre added to
common salt dissolves nearly as much
of it as if nitre had not been previously
dissolved, and even after the double
Saturation the water will be capable
of dissolving more nitre. This may depend
upon a fresh portion of water introduced
by the common salt. 12 or 14 Grains

of Corrosive Sublimate may be dissolved in 7i of water, but if we add a few Grains of Sal Ammoniac the water will dissolve four times as much. The solution of Salt is also expedited by the Agitation of the vessel, and the Division of the Cohend into smaller parts. —

Various are the methods for recovering Salts from their Menstrua, by Evaporation, Crystallization, or Precipitation. — Alcohol added to a solution of many Salts precipitates them &c: if to a solution of Epsom Salt be added a Portion of Alcohol, the former will be precipitated. fixt Alkali has not in any State so much water as it naturally

The Table of Neutral Salts

Acids	Alkalies	Neutrals
Vitriolic Acid	Vegetable	Vitriolated Tartar
	Fixed	Glauber Salt
	Volatile	Vitriolic Ammonia
Nitrous Acid	Vegetable	Common Nitre
	Fixed	Red Nitre
	Volatile	Nitrous Ammonia
Muriatic Acid	Vegetab.	Digestive Salt
	Fixed	Common Salt
	Volatile	Common Ammonia
Vegetab. Acid	Vegetable	Regen? Tartar
	Fixed	Polychres ^m of Rochelle
	Volatile	Vegetab. Ammonia

requires, therefore it precipitates Metals
 from their Menstruums. — Liquors have
 also the same Effect upon those Salts
 of which the Acid applied enters into the
 Composition. as a proof of this we shall
 find that fixed veg. Alkali added to a
 Solution of Nitre precipitates it, and unites
th w. the Nitre. and w. Respect to th second
 Proposition we shall find $\frac{1}{4}$ Addition
 of concentrated Vitriolic Acid to a Solution
 of Glauber Salt in water is immediately
 succeeded by a precipitation of $\frac{1}{4}$ Salt.
 we may employ Evaporation for th $\frac{1}{4}$
 obtaining a Crystallization w. all $\frac{1}{4}$ Salts
 except the volatile. The Practice is also
 much less applicable to the Liquors than to

the fixt and neutral Salts. The Fixity
 however is proportionable to their power
 of Attraction, strongest in the bittrick
 & weakest in the vegetable. in removing
 Salts from their Menstrua we may
 evaporate to dryness, or Crystallization.
 the former practice is never to be employed
 except when the Salt will not crystallize
 because Salts when deprived of the water
 necessary for their Concretion, suffer a
 Decomposition, & often receive an
 Impyrements. Even when Evaporation
 is requisite we ought to lessen & Appli-
 cation of Fire by every other Practice

that will assist us, by exposing it to $\frac{2}{y}$.
 gentle Heat of the Sun or to the action of
 the Air. in these Operations we may use
Dr. Hales's Machine for promoting Eva-
 -poration wth great Advantage. hence we
 see the Reason why Common Salt is
 so much inferior to Bay Salt both
 in the Beauty of its Crystal, and Anti-
 -septick Quality, the former being Ob-
 -tained by boiling heat, and the latter
 by the gentle Heat of the Sun. The general
 Rule for knowing when $\frac{2}{y}$ Evaporation
 has proceeded far eno^g, is to evaporate
 till a pellicle appears upon $\frac{2}{y}$ surface

of the Liquor, and then set it to cool, and
 crystallize. This Rule however is not
 general. for in some Cases as in the
 Crystallization of nitre no pellicle appears
 at all. Therefore we must judge by the
 Quantity of the Menstruum evaporated, or
 by taking a few Drops to cool, of this sort
 is like. If we would have large fair
 Crystals we must cool the Liquor slowly,
 if it is cooled suddenly, and in large vessels
 the salt cakes. The Manufacturers of
 Gun-powder avail themselves of this
 Practice for reducing the nitre to powder
 at the time they obtain it by evaporation
 when more salts than one are suspended

in a Menstruum we must separate them
 by vaporation, taking advantage of a
 great Disparity in the Shape & or Size of
 their Crystals or of their Solubility in water.
 E.g. a Quantity of water that in $\frac{2}{3}$ com:
 -mon Temperature of the Air dissolves $\frac{1}{3}$ of
 Common Salt will dissolve $\frac{1}{6}$ of Nitre, but
 if the water be raised to a boiling heat,
 the solubility of the Nitre is almost unli:
 -mitted, while that of Common Salt is
 increased in a proportion considerably
 less; hence it is evident if we evaporate
 the Liquor properly a large Quantity of
 Common Salt will be crystallized when all
 the Nitre is entirely suspended. so $\frac{1}{4}$ by repea:
 -ted vaporation w: $\frac{2}{3}$ Addition of fresh water

we may separate the salts very accurately.
 This Practice occurs wherever Nitre is made,
 & likewise when fossil Alkali obtained
 from Sea weed, is to be separated from y.
 Common Salt which always adheres to
 it. The solubility of fossil Alkali is to
 that of water :: 8:3. we must here ob-
 serve that previous to the Vaporation
 of Mineral waters we ought to purify
 them by Filtration, or Clarification.
 Animal Fluids, w^{ch} entangle y^e particles
 floating in a liquid, and retain them
 in a Coagulum.

That the Air is extremely mixed any

for Crystallization appears from the following Experiment. If a supersaturated Solution of Nitre be closely confined while hot in a proper vessel, the Liquor will remain for any time in the open Air perfectly fluid, but if the vessel be opened, and [&] external Air admitted, the superfluous Quantity of Salt w^{ch} the hot water suspended will instantly subside. —

It has been laid down as a certain Rule that we may distinguish Salts by the various Forms w^{ch} each assumes; yet this Rule has given Rise to innumerable Errors, since the Shape into w^{ch} any Salt concreted is never constantly uniform. for Instance common Salt usually

forms crystals of a cubic form, but two
 of them very frequently join, and form
 a Parallelepiped. Some salts form hex-
 agonal prisms, but these also form
 cones or Trueta of cones. They often
 concret in the same form: as Glauber
 salt and nitre which have been fre-
 quently mistaken for each other. all y:
 we can say upon this subject is that
 vitriol: Factar generally concret into
 hexagonal Pyramids; Common nitre
 Glauber salt into hexagonal prisms. y:
 Crystals of the ^{former} ~~latter~~ are usually larger.
 — Cubic nitre into Rhomboidal, & com-
 mon and digestive salt into cubical

Crystals.

Salts not only concreate in particular forms, but also in a determinate position, generally vertical to the plain on w^{ch} they fix. common Salt concreates usually on the surface of the liquor: Nitre in a perpendicular, and Glauber Salt in a horizontal Position to the Bottom of the vessel. I formerly imagined that these Positions were very permanent, but I have found by Experiment that the Concretions begins where the vessel is coolest, so that by applying Cold to one part of the vessel, sooner than another we may determine at pleasure when the Salts shall begin to crystallise. I took this Hint from

M^r Reameur on Antimony. - This
 as we generally have it consists of a
 Bundle of Fibres whose Direction is from
 the Apex of the Cone towards the Basis. The
 Reason of this Direction of the Fibres seems
 to arise from the Shape of γ : Antimonial
 Horn, which is a Cone inverted, & conse-
 -quently the Bottom would cool soonest,
 for M^r Reameur found that by keeping
 the Bottom of the Horn in warm Sand,
 and applying a cool Body to the Side, γ :
 Direction of the Fibres became horizon-
 -tal.

Besides the Air which we have shew'd
 is extremely necessary for promoting the

Crystallization of Salts, they all retain
 a proportion of water, the dissipation of
^{ch} w: is always attended w: the Demolition of
 their Crystalline Structure, w: may be again
 recovered by a proper Addition of water. y:
 Crystals of Glauber salt retain $\frac{3}{4}$ of water,
 Nitre receives only $\frac{1}{2}$ of water into its
 Crystals. vitriolated Tartar receives still
 less. hence the distinction of Crystallized
 deliquescent Salts. in those of y: Above
 mentioned Salts w: ^{ch} are disposed to crystallize
 at the sides of the vessels, if Heat be applied
 thereto, the Crystals push each other till
 they rise over the Brim. This was once
 a very surprising Phenomenon,
 is termed the Efflorescence of Salts. There is a

curious Fact relating to Crystalline & diluquent Salts, that the former generally Cold, and the latter that when mixed wth water.

When neutral salts are crystallised wth water, the mass is expanded. Selenites (which have been very abundantly kept from the Glass of Caline, and transferred to y^e of Earthy Bodies) suffers a very remarkable Expansion when calined, and mixed wth water. Hence its usefulness in receiving the most minute Impression of a mould, and hence y^e Bursting of a Vial if accurately, and suddenly closed. After being filled wth a mixture of Selenites,

and water.

Having premised the general Observations concerning Salts we shall proceed to consider each particular Object of Chemistry in the following Order. 1st we shall examine whether the Substance is Natural, or Artificial, simple or Compound? - If natural we shall examine in w^h State it is presented by nature? if Artificial by w^h means it may be obtained? if Compound w^h Bodies compound it? - 2^{ndly} we shall consider its Substance both in itself, and as relative to other Bodies, w^h may be strictly called its Chemical History, and this the whole I shall

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adopt the Order before established begin:
-ning with the saline..

Of the Vitriolic Acid

Vitriolic Acid is a native substance. nor does it appear that it can be produced by Art. it is seldom presented by Nature in a pure state, being generally combined th w: other Bodies, as w: fossil Alkali into Glauber salt - w: th fossil Oils, but never th w: Animal or Vegetable Bodies.

It has been a matter of controversy whether it appears even in fossil Oils. it unites th w: Phlogiston into Sulphur, & as Sulphur enters into the composition of most Metals, the Vitriolic Acid frequently unites th w: them especially w: Iron forming th green - w: Copper forming blue, and w: Zinc forming ^{white} vitriol. it is found

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^{the} w: Earth. forming ^{the} w: the calcareous
Selenites, w: Magnesia a salt much
resembling Glaubers - and w: part of com.
mon Clay Alum. it is found in Mineral
waters as accompanying Other Bodies
diffused therein, or if it be found pure it
is only in consequence of the water's work-
ing it from some Body w: has suffered a
Decomposition. This often happens to Pyri-
tes from the action of the Air. we sometimes
see the Effects of bitrioli Acid in y^e Air,
but whether it is there present in its
separate State, or attending Other Bodies
exhaled into that fluid we have not
determined by any Experiments. The fol-
= lowing

Arguments are offered to prove that this
 Acid exists in the Air independant of other
 Bodies i. If you expose first vegetable
 Alkali to the Air, and then crystallize it,
 the Crystals will have the Appearance of
 vitriolated Tartar. 2.nd That Metals are cor-
 -roded, and the Colour of Silks changed by being
 exposed to the Air. To the 1.st of these Argum.^{ts}
 we may Object that no satisfactory proof
 is shown that the Salt produced is was
 vitriolated Tartar. To the 2.nd we may Object
 that the very same Effects arise not only
 from the Action of Acids, but of y^e Alkaline
 and neutral Salts, many of which we
 might more reasonably expect to find
 in the Air than the vitriolic. This Acid

is so universally diffused throughout γ .
 Bowels of the Earth, γ . Some have supposed
 -ed that it floated w: ^{the} vapours in all
 subterraneous caverns, which Hypothesis
 is true perhaps w: ^{the} Respect to all especially
 such as are delirious. When in γ floating
 state just mentioned to which it is reduced
 by an accidental Decomposition, it becomes
 volatile. it appears likewise γ : it is
 present in the Electrical Ether, from the
 Effects which γ : latter has in changing γ .
 Colour of Roses and violets - from γ Smell
 which it produces after Explosion, and
 from the Taste w: ^{ch} People have sometimes

received after an Electrical Shock. if we
 were more certain of the presence of O₂
 in the Electrical fluid. we might be induced
 to recall the Objections made to ^{the} Univer-
 sal Diffusion of it thro' the Atmosphere. The
 Phosphorus of some Animal Substances
 contains an Acid very similar to it, but
 not proved actually to be the vitriolic.

After the Incineration of Vegetables a Salt
 is found very much resembling vitriolated
 Tartar. the Experiments however upon
 this Subject are few, deficient and in-
 accurate. it must still be a Subject of
 future Inquiry whether the Salt of the
 Vegetables is really vitriolated Tartar?

If so, whether it originally existed in the entire vegetable? - or whether it was introduced in consequence of Incineration?

The bittrich acid is chiefly procured by ^{the} for the purposes of Art. from bitriol, Sulphur and Alum. The practice upon ^{the} latter is now entirely neglected. bitriol & Sulphur are most generally employed; of these Sulphur is to be preferred since it is supposed to contain $\frac{15}{16}$ of bittrich acid. You will find Directions for conducting these Processes in Macquer and Berthollet. I must here observe ^{that} I shall seldom enter into a Detail of the Process, as they are described w. ^{the} sufficient accuracy by Macquer.

16/ I shall always therefore suppose that
you have Recourse to this Book, & only
make a few Observations as I find Occasion.

With Respect to the Practice upon vitri-
ol I shall Observe that $\frac{1}{2}$ Calcination
before Distillation serves not only to dissipate
the large proportion of Water con-
tained in the vitriol w^{ch} might otherwise

Obstruct the Process, but also to prevent
the Fusion of the vitriol during Distilla-
tion, w^{ch} would infallibly break our
Vessels. Earthen Vessels are most proper for
this purpose. The Heat must be very gra-
dually increased till watery Vapours arise,

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Then we must keep it equal till they rise
copiously. The Heat must then be
increased till the fluid begins to rise,
the Heat must again be preserved equal
till white clouds appear; After these
are removed we may increase the
Heat to any possible Degree. The Stop-
ping the Distillation at a proper time
can only be understood by those who
have been very conversant in the Ap-
pearances which occur in the process.

This Sulphur contains such a re-
markable proportion of fluid, yet not
more than 2 or 3 Ounces could be ob-
tained from a pound of Sulphur by any

of the former practices. The rude unprofita-
 -ble practice invented by Geber has long
 been deserted. The next method was "per
 Campanam.. but the air in the Bell soon
 became too hot for condensing ^{the} fumes,
^{or} w: arose from the sulphur below. Homburg
 improved upon this method by inserting a
 long tube for admitting the air. This tube
 suffered a great quantity of the fumes
 to escape. in short all attempts were
 ineffectual till a chemist of Holland some
 say one Cornelius Drebel practised it
^{the} w: excessive large vessels, & ^{the} w: the addition
 of nitre, ^{or} w: enabled the sulphur to inflame
 without any immediate communication ^{the} w:

the Air. The Quantity of Nitre is said to
 have been about 6 pounds to 100 of Sulph.
 These proportions are so unequal, that
 their union ^{ch} w: would certainly take place
 in distillation was attended w: no Incon.
 -venience. Mr Ward introduced a method
 into England, and obtained a Patent for
 the practice, by w: he procured a very great
 Proportion of Acid from the Sulphur.
 - a Gentleman having discovered ~~it~~
 - ~~the~~ Process settled a Factory at Preston.
Pans in Scotland. it is however a secret in
 the hands of very few People. various con-
 - jectures have been formed concerning
 the Method of this Practice. from the

uncommon size of the vessels w: they
 procure, some have imagined that it is
 only some trifling Improvement upon
 the method just mentioned of Cornelius
Drebbel. M^r Döbry in his "Laboratory laid
 open", pretends to have discovered ^a true
 Practice, but whether w: certainty or not
 we cannot determine.

The Practice w: we have directed for green
 vitriol must be observed in ^a Distillation
 of other vitriols or Alum.

This Acid as we receive it from ^a Manu-
 factories always contains a large pro-
 portion of water, and it is more or less of a
 dark colour occasioned by ^a presence of
 foreign and chiefly infammable matters, all

of which change the Colour of this Acid. to
 Obtain it then free from Adhering matter
 we must subject it to frequent Distillations.
 - the transparency of the Acid is a mark
 of sufficient purity for common purpo.
 - ces. but the most certain Rule is the
 Examination of its Specific Gravity at
 every Distillation, and when its Gravity is to
 $\frac{2}{1}$ of water as 18 to 10 it is sufficiently con-
 - centrated for any purposes of Arts ^{or} Chemistry.
 we also rectify the Acid of Vitriol by Open
 Evaporation, as the water and Phlogiston
 are more volatile than the Acid; but this
 is attended wth a large Dissipation of $\frac{2}{1}$ Acid.

Having now considered the different
 Methods of Obtaining the vitriolic Acid,

Let us next examine its Properties Alone &
 as relative to Other Classes of Bodies. The
 Vitriolic Acid is generally fluid, tho' it
 sometimes forms in Concretions. Mr.
 Stoll says it is reduced to a solid form
 by distilling it w: intense Heat & close
 vessels. I suspect that its Disposition to
 Solidity depends upon the presence of in-
 flammable Matter. This Subject however
 is not sufficiently illustrated by Experiments, so
 we are not certain by w: it is rendered solid,
 nor can this Effect be produced by heat
 tho' it often happens accidentally. its
 Specific Gravity is greater than y: of any
 Other Liquid except Quick-silver. When

pure it is perfectly colourless & emits
 no sensible odour. When mixed w: a very ^{the}
 small portion of Phlogiston it assumes a
 brown colour, and if the quantity is
 increased it will proceed to perfect black-
 ness.

It unites w: every species of acid efflu-
 vesing and generating Heat. I dare
 not however affirm whether it unites
^{the} w: the pure acid, or the water they gene-
 rally contain. They certainly unite w:
^{into} a substance possessing ^{the} proper-
 ties of neither. Thus Nitre & muriatic
 acid do not act upon Gold in a separate
 state, but when combined they form an

Aqua Regia that readily dissolves that
Metal. —

It unites w. all Alkalis effervescing
and generating Heat. The former of these
appearances is not universal since there
is a state of the Alkali in w. the addition
of bitridilic acid is attended w. no ^{eff} effervescence,
but more of this when we treat of Alkalis.
— Two Phenomena however constantly
result from their union viz: ² Generation
of Heat, and the Production of a neutral
Salt, preserving the Properties of neither ² y.
acid nor the Alkali. These Salts differ
according to the Species of acid employ-
ed. They may be seen in the Table of Neu-
tral Salts. it also dissolves & attracts

Alkalies more strongly than any other Acid,
and it is in consequence of this property
that we can separate ^a Acids from any other
Neutral Salts as we observed before. —

The vitriolic Acid unites wth Bils in gene-
-ral, producing Effervescence, Heat, and
more or less of a dark colour. This mixture
subjected to Distillation produces a portion
of genuine Sulphur. it is doubted whether
vitriolic Acid admits of any combination.
One would imagine that it does not,
since Sulphur appears always saturated.
-ed, yet some of its Effects deserve Attention.
Sulphur moistened wth O^r runs in ^a Air
& Deliquium, and becomes inflamm^{le}.

- It suffers a change also by Digestion.

Vitriolick Acid unites w: all ^{the} Metallic Bo-
= dies except Gold. Some have tho't that
Gold might be combined w: it. it suspends
many of them in a fluid form. Others it
only corrodes. it will not dissolve Iron
when highly concentrated, but requires Di-
= lution. This is the case also w: ^{the} Lime, but
Copper requires a very concentrated Acid
for its solution. Most of the other Metals
require not only a very concentrated
Acid for their solution. but also of Time
= time of boiling. Such as Silver & Lead
Tin, Antimony, Bismuth, Quicksilver
& Arsenic. its Effects upon Platina & Nickel

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Sobalt have not been ascertained as
these Metals have been but lately discov-
ered.

Vitriolic Acid unites w: ^{the} Absorbent Earths
of all kinds w: ^{the} Ferrous & ^{the} Heat. w: ^{the} y
Species called Calcareous, it forms Salinities,
w: ^{the} Magnesia Alba a purging bitter salt,
- w: ^{the} Animal Earth a salt to w: no name
has been affixed, and w: ^{the} Earth of Alum
a salt of the same name. M^r Magnesia
informs us that Earth of Alum, and
Vitriolic Acid will not crystallize except
a over proportion of the Earth be added.
This is a curious Fact, the Rationalia
of which we ^{do} not understand. —

Vitriolic Acid unites w. water. in a fluid
 State it generates Heat, but w. Ice it ge-
 nerates Cold. in a concentrated State
 it attracts moisture from the Air.

We have not yet determined its Effects
 upon the Air. it seems however to show
 a peculiar Relation to the Mephitic Spirit.

It dissolves ~~all~~ all, or a part of
 every Animal, & Vegetable Substance,
 generating Heat, and producing more
 or less of a black Colour, in proportion to
 the Phlogiston they contain. it checks also
 the virous Acridous, and putrefactive Fer-
 mentations.

Of the volatile vitriolic Acid.

We have considered the Vitriolic Acid

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hitherto in its first state, ponderous in-
-odorous, and emitting no Fumes. Let
us now consider it in its volatile state,
less ponderous, Odorous, and copiously
emitting ^{pungent} ~~volatile~~ Fumes. D. Stahl
accidentally discovered the method of volati-
-lizing this Acid. While he was distilling it
a sudden stream of Air broke & ^{the} vessel, &
on examination he found that ^{the} Liqueur
was volatilized. it is obtained also volatile
from Sulphur, White vitriol, & from all
Combinations of the Acid w: ^{the} Oils or Alko-
-hol. The volatile Acid is disposed like ^{the}
former to congeal in w: ^{or} state it loses
its Odour, but recovers it w: ^{the} Density.

It discharges the Colour of Violets altogether,
 without turning them red. Their Colour may
 be recovered by a fixt Alkali. Neutral formed
 by it may be decomposed by the fixt vitriolic
 Nitrous, or muriatic Acids. It unites with
 all the other Classes of Bodies nearly in $\frac{2}{4}$:
 same manner as when fixt. Its chief
 Peculiarities are as follows. it is more
 powerful Menstruum to Alkalies than $\frac{2}{4}$:
 fixt acids. the fumes of 16 ounces of Sulphur
 will dissolve a greater quantity of Acid,
 than 16 ounces of the most concentrated
 fixt Acid. its Effects upon Inflammables
 are inconsiderable. it unites difficultly ⁱⁿ:
 Alcohol, nor will their Union produce

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Other. its Effects upon Metallic, Earthy
watery, and Aerial Bodies are nearly [&] same
as those of the fixt, Only less powerful. The
Same Observation is true wth Respect to ^{the} [&]
Animal and Vegetable. it may be re-
-red fixt by a gentle Calcination wth fixt
Alkali; - by Addition of water - or by Com-
-munication with the Air for a long time.
- For an Acc^t of the Lemonia of this Acid
of all the Other Salts, see Black's Chemistry.

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